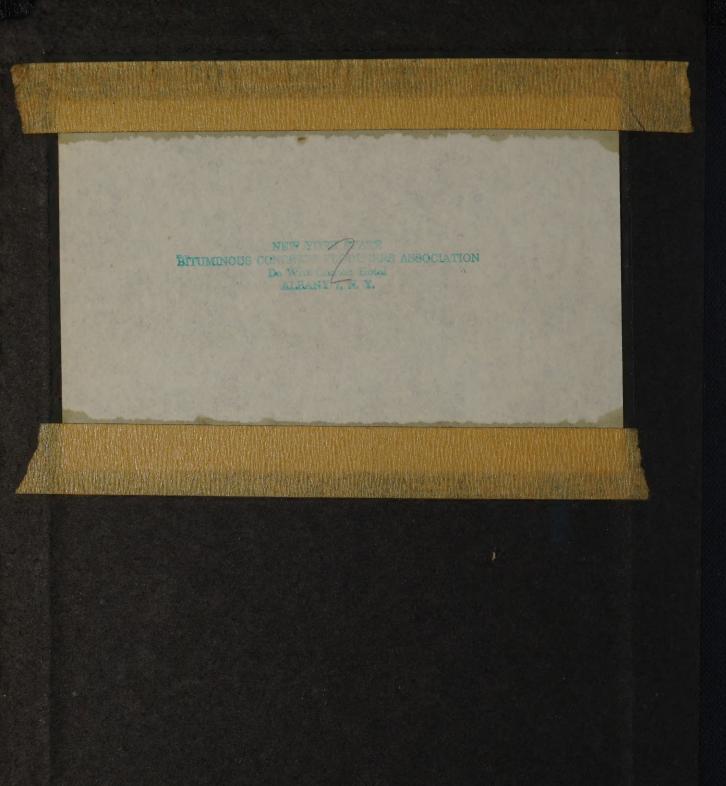
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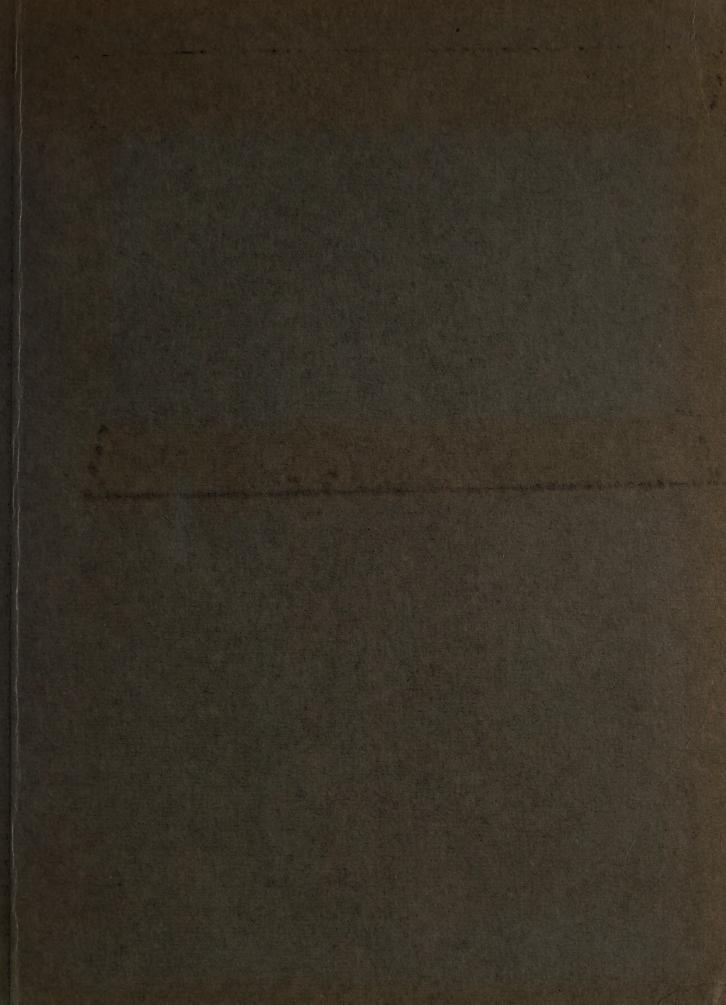
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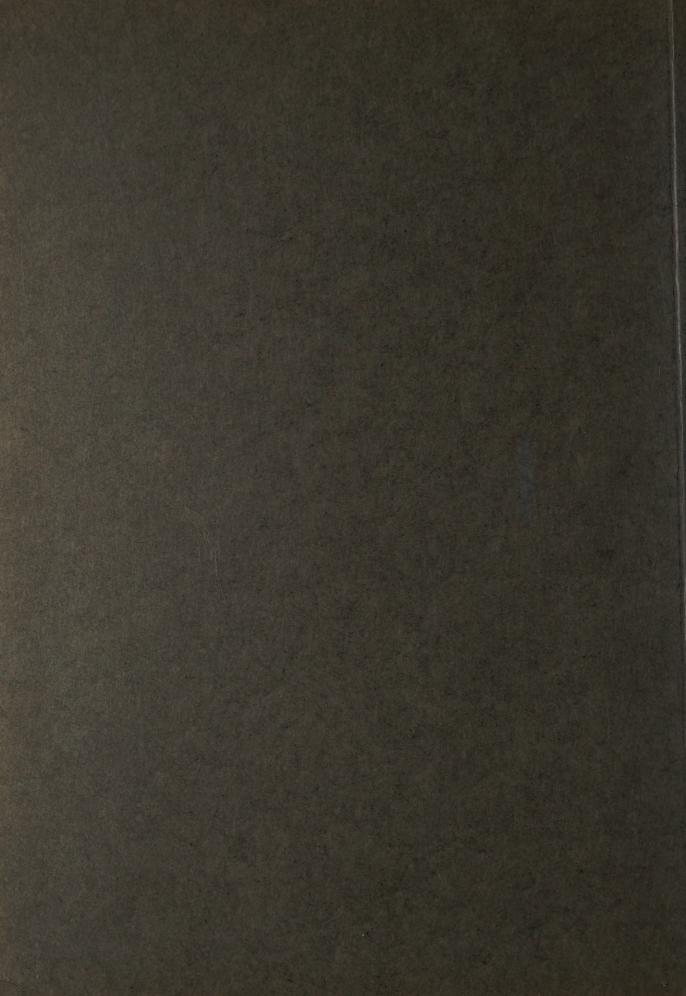
FINE AGGREGATE IN

BITUMINOUS CONCRETE

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A STUDY OF PRESENT PRACTICES IN NEW YORK STATE WITH REGARD TO FINE AGGREGATE IN BITUMINOUS CONCRETE

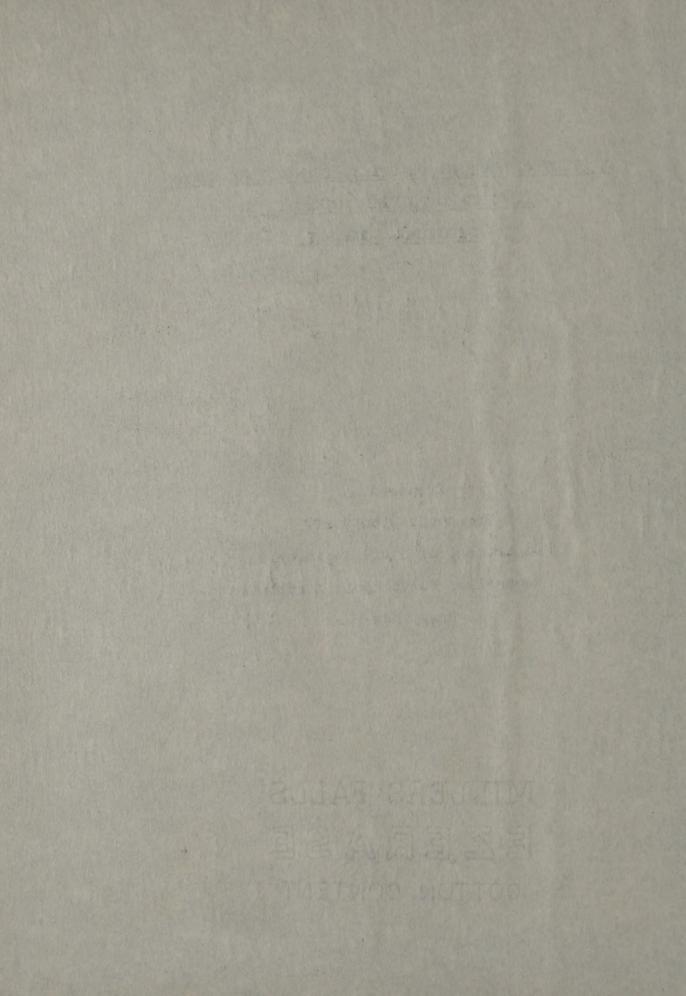
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Rensselaer Polytechnic Institute

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ACKNOWLEDGEMENTS

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Grateful acknowledgement is made to the New York
State Bituminous Concrete Producers Association for the
grant to make this study, particularly the cooperation and
assistance received through them, their staff and employees
at the plants.

The valuable assistance and counsel of the District and Material Engineers and the Bureau of Physical Research of the New York State Department of Public Works is also sincerely appreciated.

Acknowledgement is made to the National Bituminous Concrete Association for their technical literature survey.

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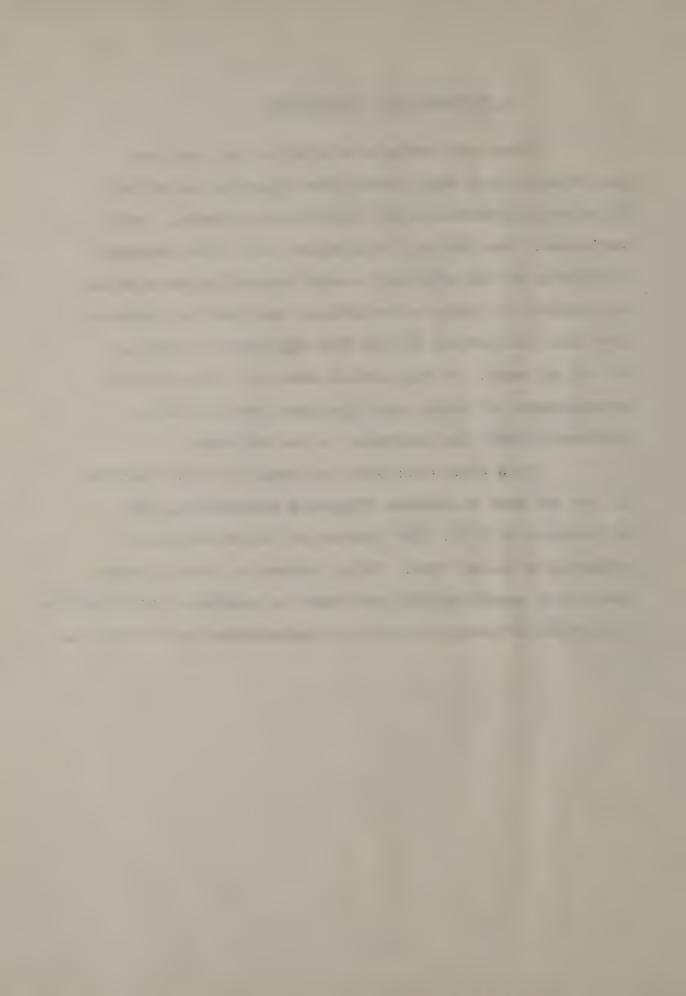
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A STATEMENT OF THE PROBLEM

Some wide variations exist in the permitted use of artificial sand as the fine aggregate in hot mix bituminous pavements in New York State highways. These variations from District to District range from complete acceptance of the material through decreasing percentages, to complete rejection of artificial sand and the requirement that 100 percent of the fine aggregate be made up of natural sand. At the present time, no basis for the establishment of these specifications seems to be in existence except the judgement of the Engineer.

This wide variation was brought to our attention by the New York Bituminous Producers Association, Inc.
in December of 1961. The concern of the producers is primarily a factual one. It is desired to know if these individual specifications are based on technical considerations, properties of local materials or characteristics of the mix.



SCOPE

The scope of this study was expressed in a proposal presented to the New York State Bituminous Concrete Producers Association and explained by the following as a plan of study:

"A PLAN FOR THIS STUDY

Phase (A) To gather information concerning the present practices of various highway organizations in regard to the use of artificial sand.

Phase (B) To determine from the literature what studies have been conducted concerning the use of sand size aggregate resulting from the crushing of quarried rock.

Phase (C) To conduct tests upon bituminous mixes designed with varying percentages of artificial and natural sands making up the fine aggregate content of the mix.

- 1. Laboratory samples
- 2. Field samples

Phase (D) To correlate the information obtained in order to evaluate the position of this type of aggregate in the production of asphaltic concrete and its limitations if any.

The phases of this study indicated above are so interdependent that the details of operation are difficult

to establish at this point. Both phase C and D must develop from the information obtained in phases A and B.

It is therefore proposed that phase A and phase B be presently undertaken.

Phase (A) The gathering of information shall be done by correspondence with and interviews with the various New York State Division Engineers and Engineers in corresponding positions in other states.

- (1) Information shall be sought concerning:
 - (a) The permitted use of artificial aggregate.
 - (b) The type of natural and artificial aggregates available within the area.
- (2) Samples of these available aggregate shall be obtained.
- (3) Where possible, samples of actual mixes being laid on highways under various conditions of design will be taken and cataloged for later testing.

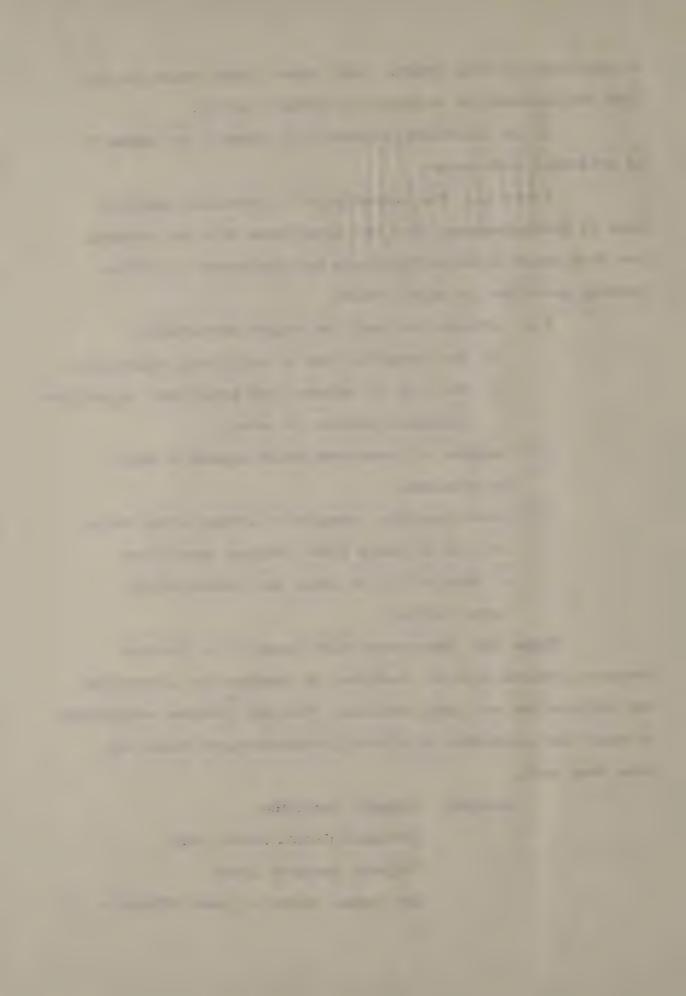
Phase (B) Concurrent with Phase (A) a library research program will be conducted to examine the literature for information and data resulting from any previous evaluation of sand size aggregate artificially manufactured which may have been made.

Sources: Asphalt Institute

Portland Cement Association

Highway Research Board

Am. Assoc. State Highway Officials, etc.



Upon the completion of the above phases A and E, the continuance of the study into phases C and D can be more completely detailed.

At this point, a detailed proposal for the testing and analysis will be presented as the conclusions from phases A and B."



PROCEDURE

The questionnaire and letter shown in Appendix A was sent to all of the producer members of the New York
State Bituminous Concrete Producers Association to determine what percent of artificial sand was being used by their plants. The results of this questionnaire defined the limits of permitted artificial sand from 20% to 100% and located each in their respective Districts (Exhibit 1, Appendix A).

A summary of the answers from 21 questionnaires is shown in Appendix A.

As a result of this preliminary investigation, the following approach was undertaken:

- A. Interviews with all District Engineers or Materials Engineers were conducted to gather information concerning the present practices of the ten Districts in regard to the use of artificial sand. Emphasis was placed on the philosophy, background, basis and future plans of these specifications.
- B. Top mixes, New York State 1-A & 1-AC armorcoat, were sampled from most Districts in order to conduct tests upon these mixes designed with varying percents of artificial and natural sands making up the fine aggregate content of the mix.
- C. A survey of currentillibercharmes conducted to determine what studies had been made concerning the use

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of sand size aggregated resulting from the crushing of quarried rock. Skid resistance and stability were the main objects of most of the reports presented in the following sources:

Asphalt Institute

Association of Asphalt Paving Technologists

Highway Research Board.



INTERVIEWS WITH DISTRICT ENGINEERS

A. Background Material on Practices of DPW Districts Relative
to Aggregates for Amphaltic Concrete

The state has Six standard mixes: 1A, 1AC, 2A, 2B, 3A, and 5A. For each mix, it designates limits of gradation of aggregate, and asphalt cement content. Fine aggregates (passing 1/8" sieve) are classified as "a", "b", "c", "d", or "e" depending on standness test results, and (for classes "a" and "b") percent content of kaolin, quartz, and feldspar. Fine aggregates can be clean natural sand, rock sand or rock screenings crushed from approved stone, or slag stone, or combination. Only "a", "b", "e", or "d" fine aggregates are permitted for asphaltic concrete.

Mineral filler (the portion of approved aggregates passing No. 200 screen) can be limestone dust, portland cement, diatomaceous earth, flyash or other approved material.

within the framework of the standard state specifications (1957 Edition) the Districts have considerable freedom to custom-tailor to their local preferences. They can of course operate as desired within the gradation and asphalt content limits for the given standard mixes. They may not relax the State specifications but they are permitted to make them more rigid (unless expressly forbidden to do so). They may designate special mixes: e.g., one district has recently made considerable use of Item 51X, which is a

and the second of the second o

variation of Item 51, the standard pay item for a 1A mix.

Mix design is not static. Districts have found it desirable from time to time to exercise their given discretionary powers to meet local conditions of aggregate availability, climate, workability of mix and pavement performance. No pavement job is perfect and sometimes a single bad stretch of pavement has been the cause for specification changes applied to many subsequent projects.

The local specification differences which are of concern in this report have to do with the percentages of fine aggregate which is required to be "natural sani". Within the past half dozen years, several of the Districts have established minimum percentages for "natural sand" in surface courses, either directly or indirectly through the process of elimination. There is no restriction on binders. While the State does not completely define "natural sand", it appears to be that mineral aggregate which occurs in its natural state in particles passing 1/8 inch sieve and is not a product of artificial crushing or grinding. Usually "natural sand" is largely composed of quartz and feldspar, in which case it is synomomous with "silica sand". When quarry rock is crushed, the fine particles are called "rock screenings". When "rock screenings" are clean and meet requirements for gradation, they may be properly called "artificial sand". Hence all artificial sand is made from "rock screenings", but not

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all "rock screenings" can be properly called "artificial sand", though some people use the two terms as though of identical meaning. In New York State, the most common coarse aggregates come from limestone, trap rock, dolomite and sandstone, hence these are the sources also of "rock screenings" and "artificial sand". Obviously, the sandstone would yield "rock screenings" high in silica and could be classed as "a" or "b", whereas "rock screenings" from the other sources would of necessity be classed as "c", "d", or "e".

B. Comments of Individual Districts

In the interviews with District Engineers and Materials Engineers, three definite factors were given for establishing minimum natural sand minimum percentages:

(1) skid resistance, (2) gradation control, (3) workability.

pears ago it had experienced extreme slipperiness on Route #11.

Addition of a Kentucky rock asphalt surface treatment (highly recommended in many parts of the United States for de-slicking pavements) only worsened the slipperiness. Further experimenting cultitated in substantial changes in mix design as follows:

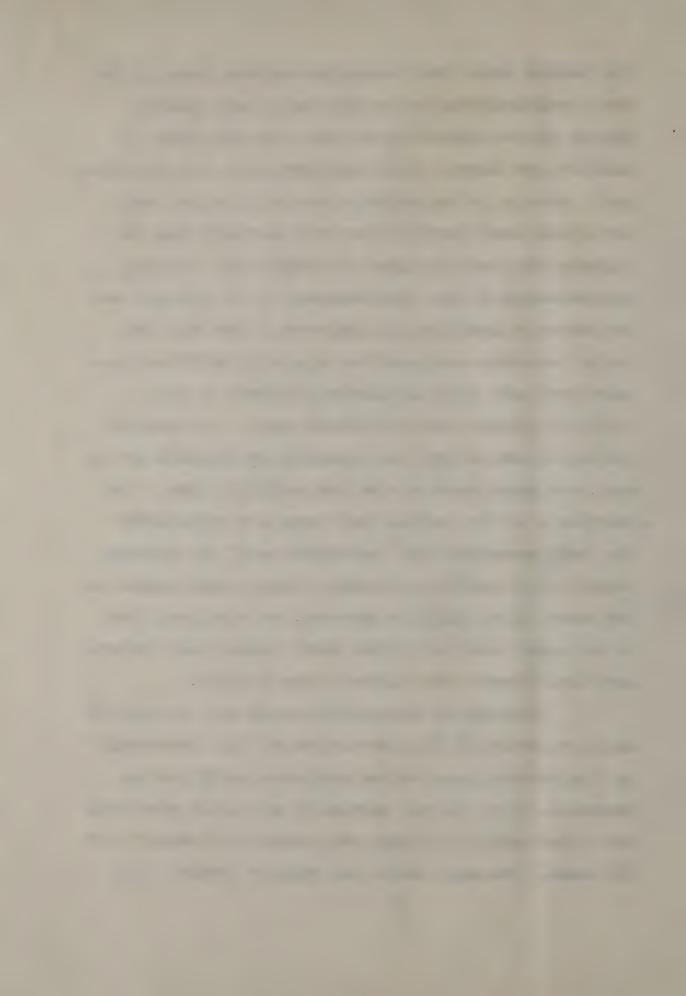
(1) mineral filler content was reduced; (2) asphalt content was reduced; (3) silica sand was substituted for practically all of the sand-size aggregate which previously had been rock screenings. These changes were incorporated into Special Item 51X now widely used by this District. Item 51X does

not mention "natural sand". It says that "...at least 35% of Top Course shall consist of sand whose Quartz and Feldspar content shall be at least 75%, and the gradation shall conform with the N. Y. State Specification for concrete sand...." Since Item 51% calls for 40% of the mixture weight to be minus 1/8", in effect 35/40 or 87-1/2% of the fine aggregate (including mineral filler) is required to be silica sand. (It should be noted that sandstone rock screenings would be permissible under this specification. Usually, however, sandstone screenings fail to meet other tests, hence for all practical purposes Item 51% calls for natural sand to the exclusion of nearly all of the artificial).

In District #8 (Poughkeepsie), for about five years, natural sand has been required as a means of quality control-specifically control of gradation and impurities such as clay and organic material. The District is very conscious of the distinction between "rock screenings" and true "artificial sand". The District feels that very few of the producers are capable of producing truly graded, clean "artificial sand" and instead the bulk of the producers want to use the entire minus 1/8" fraction of the crushed quarry rock in the mix, with the result that the gradation of the fines fluctuates from day to day, too rapidly to compensate by adjustment of the asphalt content. Natural sand, on the other hand, has been blessed by Nature with more consistent gradation resulting in better uniformity in the final mixture.

The District feels that the minimum-maximum limits of the State specifications are too far apart, hence quality control is best assured by the use of natural sand. In addition, the District feels that even with true "artificial sand", the mix is less workable than with natural sand; "artificial sand" particles are more elongated than the characteristic cubical shape of natural sand. However, this harshness is much less important to the District than the matter of gradation, as indicated by the fact that one or two plants are permitted to use 50% artificial sand where they have shown satisfactory evidence of their ability to produce true "artificial sand". The district points out that natural sand deposits are plentiful in the area, and hence costs no more than artificial sand. The District is of the opinion that there is a ready market for "rock screenings" and "artificial sand" for purposes other than in asphaltic concrete; however, this opinion is not shared by at least one producer, who also feels that he can supply true "artificial sand" cheaper than "natural sand" and thereby save dollars to the taxpayer.

District #9 (Binghamton) agrees with District #8 as to the nature of the shortcomings of "rock screenings". In this district, much of the available quarry rock is sandstone, hence the rock screenings are silica materials, but do not satisfy the other requirements for class "a" or "b" sands. For major roads, the District requires 100%



"a" or "b" sands; for secondary roads, it requires a minimum of 70% "a" or "b" sands but would like to be permitted by Albany headquarters to require 100% for secondary roads, too. The District readily agrees that the cost of natural sand is greater than "rock screenings" since there is practically no natural sand within the District. But it defends its policy vigorously as necessary to obtain acceptable quality in its asphaltic mixes.

District #2 (Utica) adopted a 50% natural sand requirement only a few months ago. It agrees with Districts #8 and #9 as to the lack of consistency of gradation of artificial sands, and also the harshness of the resulting mixes ("unworkable"). In general, this District seems less positive in the matter than Districts #8 and #9.

"artificial" sand" in the 1A mixes, but restricts to 20% its use on the less common 2A (urban areas) and 2B (bridge decks) mixes. District officials were not sure of the origin of this requirement of some five years standing, but felt that it must have been due to some fault in gradation which was troublesome with the finer 2A and 2B mixes but not with the 1A mixes. Complicating the picture is the fact that in the southern part of the District, the natural sands are deficient in certain size fractions, notably the #80 size, which thus needs some artificial sand blended with it to correct this deficiency.

the second of th

District #6 (Nornell) has no restrictions on the use of "artificial sand" but it is in the peculiar position of having had little experience with artificial sand. The reason for this is that there are no commercial rock quarries in the District (the native sandstones being under deep overburden) hence all crushed stone must be imported from other Districts. Since natural sand pits are located much closer than the rock quarries, asphalt concrete producers have always used natural sand voluntarily, because of the savings in freight cost.

District #1 (Albany), #4 (Rochester) and #3 (Syracuse) have no restrictions on "artificial sand" although District #3 is not wholly satisfied with the gradation.

District #10 (Babylon) has no restriction on the use of artificial sand, but have had little experience with the use of it, due the abundant supply of natural sand.

It was implied that they would not like to use 100% artificial sand, and, in the event it was used, special quality control would be exercised.

The above information appears in tabular form in Table #1.

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TABLE #1	1		
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Do producers	Charleston Co.	Only for LAC Armor Coat	

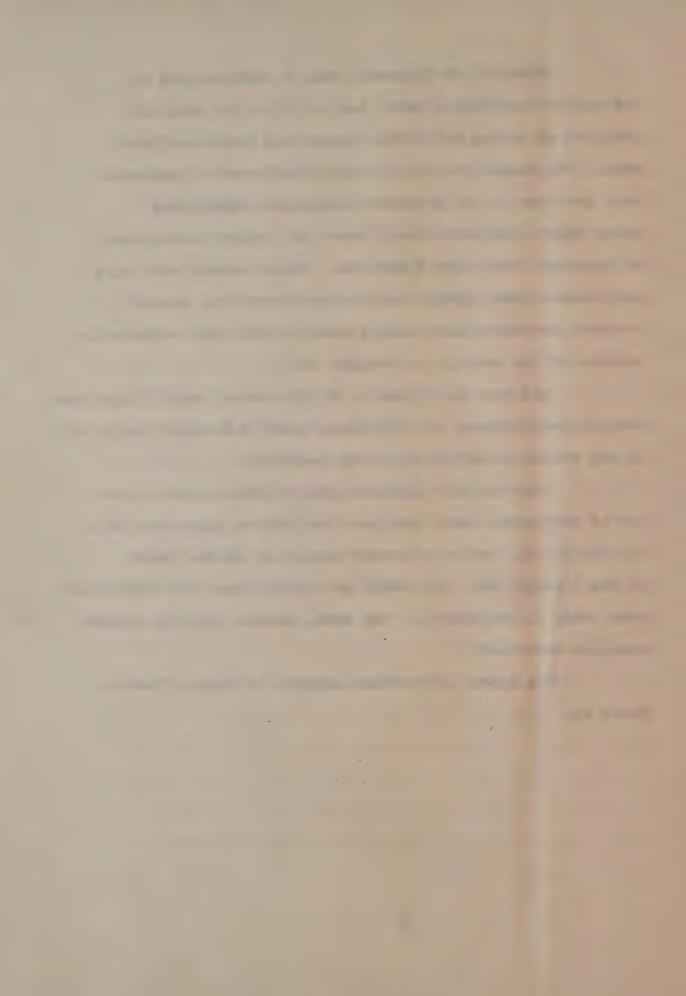


TABLE #1	Brothough a secure observed topposition by the distribution account along the	the examination stage.		the book open a second as the							COMME	TS OF INDIVIDUAL	DISTRICTS
DISTRICT	# 1 Albany	# 2	it1	.ca	# 3 Syracuse	# 4 Rochester	# 5 Buffalo	# 6 Normel	-	#7 Watertown	#8 Poughkeepsie	#9 Binghamton	#10 Babylon
Does District restrict the use of artificial sand?	No	Yes	ng ga an ann	and the same of th	NO	No	Ves	No	1	y a a seu a salla million di midi a sida gallan 1 inga addirk mendincenti balaganti o makan mendedili kamam-m M	The form of the control of the contr	Yes	No.
What percent of sand may be artificial?	100%	¥ 50 ·	ALC TO A COP	ments on any market	100%	THE PERSON OF THE PERSON OF THE PERSON AND A PERSON OF THE	1005 on Type 1A	C Systemborse Action to a		Yes	Yes	30% second rds.	Allowed but 100%
How long has restriction existed (years)?	A CONTRACT OF THE PROPERTY OF	i di mo.		VANIAL 10 (00)-100-100-100-100-100-100-100-100-100-	A ROPE	200).	20% 2A and 2B	LOCK		13%	OB	0% on Major rds	of not used
Reason for restriction	The companies are a separation of the second contract of the separation and	more	V. COM	able	ethe earliest and antique examinations are althoughly instancing their ways	TSERN AN ESTER COMMENTAL THE SERVE SAME STANDARD AND AN EXPE	3-4 years Not sure, due to	A CONTRACT OF THE STATE OF THE		5 years	5 years Wide day-day	2 years	District would not like to see 100%
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Are artificial screenings poorly graded?		1		\$.	Yes, high on 8- 20; lew on 20-80	THE WAS HE SECURITION HISTORIA ON AN ANNO SEC		oneaper		anaga, arrain da may manan a da sarah da da gabay da	Yes, elongated	on secondary,	Yes, large gap between #20 and
Are rock screenings (except limestone) permitted in P. C. Concrete?	The articles and the same of t	The state of the s		agent and the second	NO	NO	Yes	the statement with the administration of the framework		or, museup him swep (A). What who are unusually to influencement equipment states a book relation as	No	No	No
Are rock screenings poorly shaped?	the transmit than any explainable from a graph count of the sale ring a county of the sale	The state of the s			Yes, elongated	the angular contracting provident and security and securi	Not known	ing a contract the property of the contract to the page of the contract to the		ne en e	Yes	Yes	Service Services and the service services of the service services of the servi
Is artificial sand reasonably plentiful locally?	Yes	Yes	make by	1	Yes	Application of Albaryti Telescond and account of the con-	Yes	80	9	The B	Yes, surplus	Yes	No, imported when used.
Is natural sand reasonably plentiful locally?	MO	Yes	SATE OF THE SATE O			Yes, but skip	Yes	ies	4.00	Yes but often lacks required silica	Yes	Ne, mest must b hauled from Dis #2 and #8	Yes, it is exported to other Districts.
Is weahing of crushed aggregate required?	***************************************	and the second s	A ^{NE} COE TO		gap at the construction and according to the construction of the c	No.	No	. Mar (20) - 1 A A A A A A A A A A		No		Yes, sandstone No, limestone	No
Does District tend toward high or low limit of asphalt content?	4	7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	e f		Migh	alph	High	82 ₆)	The state of the s	Low	Low	High	High
Does District tend toward high or low limit of minus #200?	the title contact total for the particular total or the contact to the		As all the same		Constitution to the second sec	High	Low	LOW	A constitution of the second	Low	Low	High	
Is skid resistance a particularly acute problem?	The state and address any and alternative and the state of the state o	are scid pare-	resi	ing mo		No, no bleeding with only 15	No	No		Yes, bleeding and polishing	No	No	No
Has "polishing" of aggregate been a problem?					No	No	No	10	A STANDARD COME	Yes, acute pro- blem but solved by silica sand.	No	No	Noted difference between limestone and traprock
What types of stones are used?	Limestone, Gray Wacky Quartzite	Limesto	re		Mostly limestone some dolomite	Mostly limestone some dolomite		Mone locally sport line-	te	Limestone	Limestone, trap	Sandstone, Limestone	Limestone and traprock
How does District determine of A. C. To use?	State Spec.	State Spes.			Experience	Experience	Experience	aporience		Experience	Experience	Experience	% retained & passin 1/8" sieve.
Do producers usually need to add mineral filler to get gradation specified?	No	ge ge	1			Yes)lo		Only for LAC Armor Coat	No	Yes	Yes



TECHNICAL EVALUATION OF VARIOUS SOURCES

Marshall Compaction equipment was taken to most districts, and an average of nine marshall specimens were compacted of top mixes from the pug mill of each plant.

Six by eight inch rectangular specimens were also compacted by a modified Hubbard-Field procedure in hope to be able to run laboratory skid tests on the mix.

The laboratory skid tests were not run on these specimens, but saved in the event of future testing. The laboratory compaction techniques have not been perfected to reproduce the actual rolled pavement surfaces. The surface texture and densities of the specimens did not simulate the actual conditions. At most only relative values of skid coefficient could be expected from this approach.

The most valuable data comes from the Marshall design test procedures, where stability, flow, and percent voids can be analyzed.

It is possible to attain a high degree of control in an asphalt laboratory where the quantity of each ingredient of the mix formula is known to be accurate, and hence specific comparisons can be made. In an asphalt hot mix plant, however, the control is much less exact. Hence only the most general conclusions can be drawn from the data obtained.

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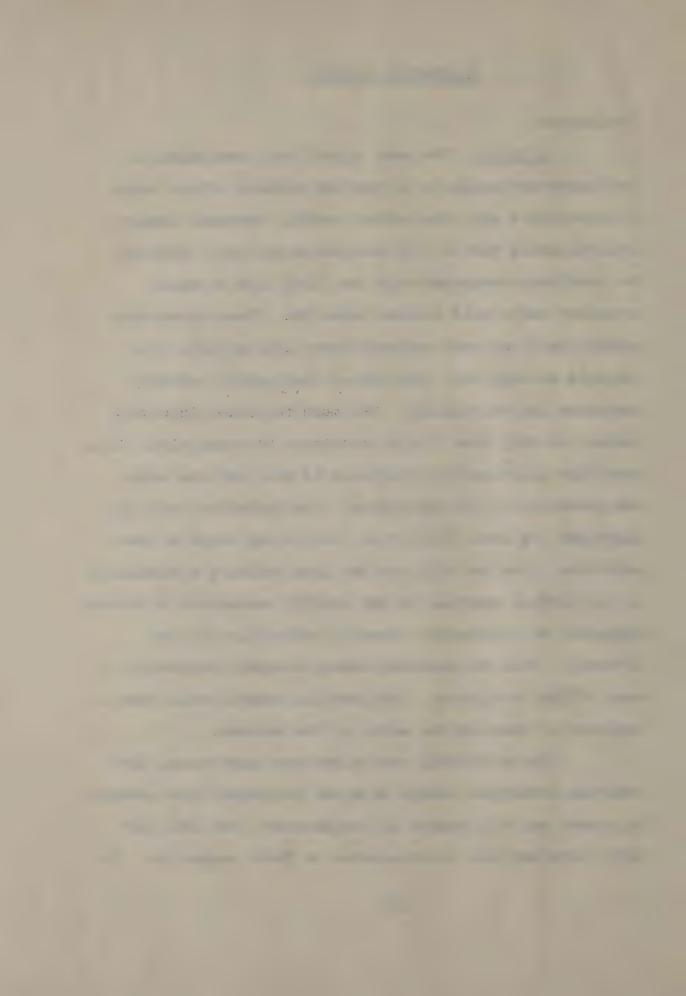
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LABORATORY RESULTS

Conclusions

% Voids. The most significant conclusion of the laboratory analysis is the low percents of air voids in those mixes with the natural sands. Marshall design criteria calls for 2% - 6% with 4% as optimum. Most of the specimens compacted with the fifty blow Marshall procedure had a void content below 4%. Those mixes with natural sand had void contents from 0.5% to 2.5%. The low void content is a function of the asphalt content, gradation and workability. The more workable mixes will compact readily with little resistance to compaction. This condition is primarily a function of the particle shape and gradation of the aggregates. The gradation range is fixed and the great difference lies in the shape of sand particles. The low void content is a definite disadvantage in the surface courses, as any traffic compaction or thermal expansion will introduce bleeding and rutting in the pavement. This was observed during Marshall compaction of some of the rich mixes. The bleeding asphalt would have a tendency to creep up the siles of the collars.

The artificial sand mixes were more harsh, and resisted compaction enough to allow the proper void content. We cannot say this exists in the pavement, but feel the fifty blow Marshall is comparable to field compaction. In



no case did we notice any evidence of aggregate crushing or breaking during compaction.

Note of the natural sand mixes with most cases those mixes with matural sand had a high % voids filled, which is accompanied with the low void content. The Marshall criteria is 75-85 of the aggregate voids filled with asphalt cement.

Most of the natural sand mixes had a percent voids filled well in the 90's.

Marshall Stability. Most of the Marshall Stabilities ran higher with the artificial sand, but not significantly higher. This could be caused by greater interlocking of the aggregates. There is no recommended upper limit for Marshall Stabilities; however, extremely high stabilities can be a disadvantage as it has a tendency to make the pavement too rigid. Consequently, any movement in the substrata will cause cracks in the surface.

Flow. The Marshall flow is a measure in 1/100 of an inch of the deformation of the specimen at maximum load. This also is a relative value of rigidity in the mix. The maximum recommended by the Asphalt Institute for 100 psi tires is 20 with no stipulation as to a minimum. All of the natural sand mixes had higher flow values than the artificial sand mixes thus showing a greater tendency of the natural sands to move and reorient before a permanent yield of the compacted mix. Excessive flow in a mix is a

definite indication that the mix will groove or develop ruts under traffic load. Flow values between 13 and 20 are assets to any pavement, thus allowing it to deform without cracking. The natural sand mixes had flow values in a range from 17 to 24 with an average of 19.7. This is very close to the upper limit to be accepted without further study.

No recommendation can be based on these few tests as to the use of natural or artificial sands or a combination of the two. However, a definite trend is prevalent, and more extensive testing of this nature should be conducted at each plant in order to make adjustments in the mix. Due to the wide spectrum of local material that exists in New York State, it appears feasible that these materials can be used in asphalt concrete mixes, provided each element will satisfy the quality control established.

A summary of the laboratory results from Appendix B is shown on the following pages, 19 and 20.

1-AC Armorcoat N. Y. State	Location			MIX CIRESTIC	Artital Sand	Pessing 1/8" Sieve	TOTAL STATE OF THE	Compacted Specific Gravity	ATT VOLUE	Volds Filled	unit weight #/ft3	Marshell Stability	ADELE
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REVIEW OF CURRENT LITERATURE

The three most important controversial arguments as to the use of artificial sand over natural sands are
(1) economics (2) skid resistance (3) workability.

Economics. The economics of the natural sands depend primarily upon the available sources and the transportation cost. In Appendix C is a list of New York State Department of Public Works approved sources of concrete sands. The sands are classified in the a, b, c, and d types which are acceptable for asphaltic concrete. Most district engineer's offices have available for distribution copies of approved sources of fine aggregate for their district. These lists change quite frequently; therefore, it is recommended that a producer in need of this material procure a more recent list from his district engineer's office.

Maps of New York State showing some quarry locations and fine aggregate natural sand sources are included in the cover page. The Stone Quarry map shows both potential and operating sources of artificial sands. These are available through the New York State Department of Public Works.

Skid Resistance. Excerpts from the First International Skid Prevention Conference held in September 1958 at Charlottesville, Virginia, are referred to when pertaining to the use of natural and artificial sands.

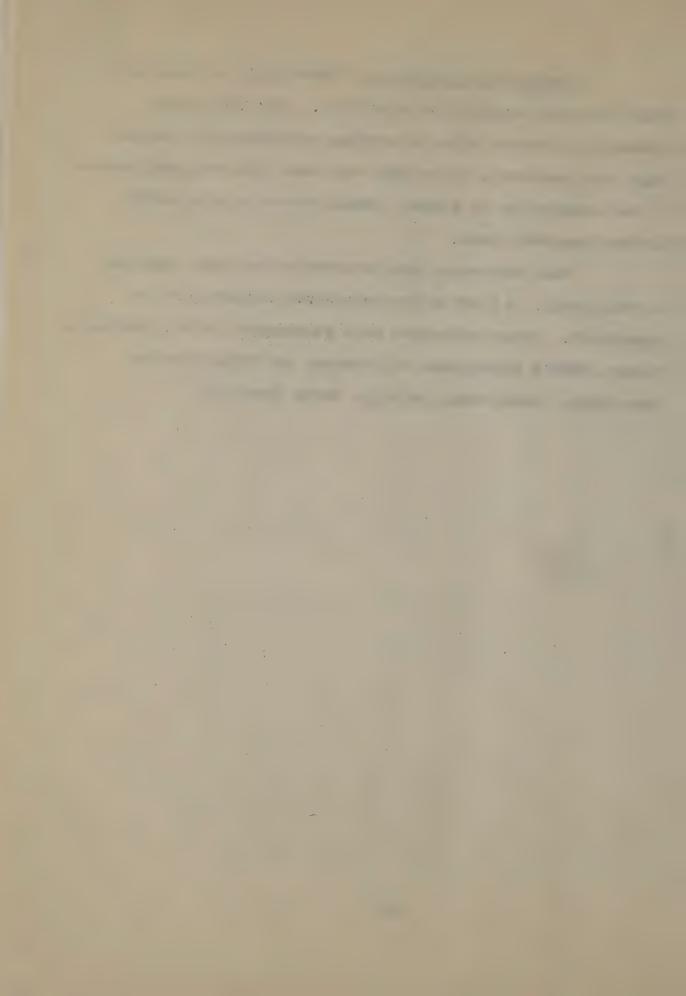
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Results of Trial Mixes. Workability is associated with the voids analysis and stability. Data from trial laboratory prepared mixes of varying percentages of natural sands are presented. This data was taken from the publications of the Association of Asphalt Paving Technologists and the Highway Research Board.

Four references are reviewed as the most important to this study. A list of the references reviewed are in Appendix C. These references were recommended by Mr. Charles R. Foster, NBCA's Coordinator of Research and Miller-Warden Associates, Consultants, Raleigh, North Carolina.



FINDINGS

At the beginning of this study, one of the investicaters expected that the matter of slipperiness would turn
out to be the dominant factor behind the restrictions on
the use of artificial sand. Largely as a result of tests
and recommendations made by Virginia, at least three other
states (Kentucky, Tennessee and Georgia) have recently
restricted the use of artificial sand to curb slipperiness
arising from the polishing of the relatively soft limestone
particles. It is interesting to note that still more
recently, Virginia has conceded that subsequent tests
revealed no significant superiority of natural sand over
artificial sand in the matter of slipperiness.

District (#7) is restricting artificial sand due to slipperiness. It is to be noted that on its worst case of slipperiness the District topped off the pavement with some four pounds of iron mine tailings per square yard broadcast on the surface after the breakdown rolling. It is interesting to speculate whether this surface treatment might not have been responsible for the curing of the slipperiness rather than the substitution of natural sand for artificial.

But the chief reason for the restrictions on artificial sand has turned out to be the unsatisfactoriness of the gradation. Since the State specifications establish

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gradation limits, it may be difficult to understand why gradation control cannot be maintained under these limits. The answer to this as given by the Districts is that for any given project a "job mix" is worked out built around the gradation of the source or sources of the aggregate to be used; but if this aggregate gradation is erratic, the final product will not be uniform. The investigators agree with this argument but feel that this does not automatically point to the necessity of restricting of "artificial sand", but only to the restricting of "rock screenings". It would seem reasonable that if an individual producer of artificial sand can produce consistent gradation as desired, then it would be in the best interests of the State of New York to permit that producer to use that artificial sand; this action could hardly be justification for a charge of favoritism. The previous sentence was predicated on the supposition that there does exist suitable equipment and procedures for producing a consistently true "artificial sand"; the investigators have not studied this question, but would recommend such a study as the next phase, now that the policies of the several Districts are known.

As to the third factor cited as reason for restricting the use of "artificial sand" - workability - the investigators have not analyzed this question either, and recommend it for study. Off-hand, it seems strange that after many years of experience using artificial sand, we should only recently have

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awakened to the fact of its unworkability; but such may be the case. In any case, it should be a relatively simple matter to compare workabilities of natural sand mixes vs. artificial sand mixes, preferably on an actual pavement project and with the cooperation of contractor-producer and District representatives.

that some experiments along these lines have not already been made within the Districts; but the fact is that some of the producers are convinced that artificial sand is not inferior to natural sand. The investigators have met with good cooperation by District officials throughout the study thus far, and they believe that they would continue to enjoy the cooperation of the Districts in the joint experiments as previously mentioned. It is recognized that it is the prerogative of the District, not the producers, to make decisions in such matters but that obviously the District stands to gain if decisions can be made more palatable or at any rate more understandable to the producers.

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Technical Evaluations. Workability has been defined as a condition of the mix that permits it to compact and handle easily. Good workability has been associated with those mixes having 50 to 100 percent natural sand. It is quite reasonable to expect rounded particles to compact easier than sharper, elongated ones. The voids analysis showed this to be quite true. However, there is a limit to how dense an asphalt concrete pavement should be compacted. This has been established at 4% air voids. Most of the natural sand mixes had void contents below 4%. The artificial sand appeared to resist compaction enough to provide for 4% air voids.

The percent aggregate voids filled with asphalt cement was considerably higher among the natural sand mixes. The designs call for 80% voids filled. Most of the natural sand mixes were well in the 90's. This is an undesirable characteristic of a too workable mix.

The average Marshall Stability ran higher with the artificial sand mixes than the natural sand mixes. The higher stabilities is best explained by the keying or interlocking of the aggregates.

Higher Marshall flow values were characterized by the natural sand mixes. This is further evidence that the particles are freer to move in the natural sand mixes due to the particle shape. This would lead one to expect more grooving in natural sand mix. However, a certain amount

of movement or deflection is necessary for flexible pavement particularly in the top courses.



Library Research. In the majority of the investigations conducted in the laboratory and in the field, the primary objections were to determine relative differences in the types and gradations of various aggregates. These types were correlated as to their skid resistance and stability qualities.

Virginia conducted probably the most comprehensive study on their pavements and overlays. They held the First International Skid Prevention Conference in 1958. The Research reports presented at this conference concluded that slipperiness was not a function of the sand size aggregates but primarily a factor of the polishing characteristics of the coarser aggregates. It was found that a sand paper finish of a silica sand mix, which is highly resistant to abrasion, would hold or carry thin films of water that cause a high speed tire to aquaplane. The more open or rough textured surface allows the water to drain around the surface particles and thus provides a more jagged surface to resist skidding. As a result of this hypothesis, polishing coarse aggregates, such as limestone and dolomite, have been restricted from the top courses.

²Marshall and triaxial compression tests were run on prepared trial mixes of varying percents of natural sand. These tests concluded that higher stabilities were

^{1.} Skid Resistance - Appendix C

^{2.} Results of Trial Mixes - Appendix C

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not a result of high densities. The natural sands produced the higher densities. The higher strengths of the artificial sand mixes were quite pronounced in the triaxile tests running usually 125 pounds above the natural sand mixes which was approximately 25% of testing range.

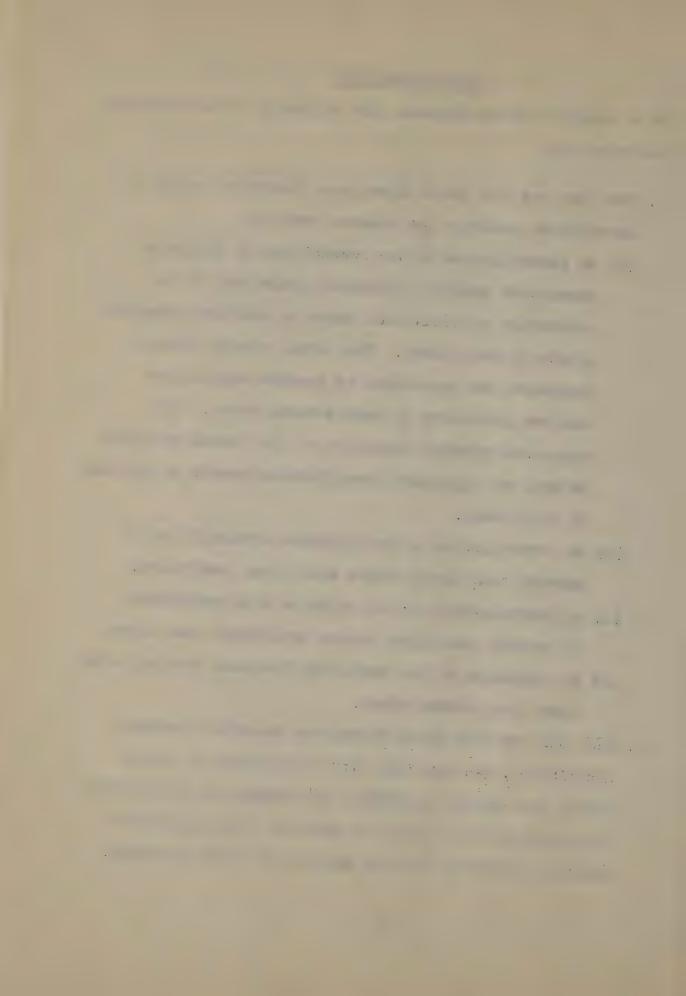
The voids analysis showed both natural and crushed sand to be very similar. This was primarily due to the fact that the crushed particles were the same aggregate type and had the same specific gravity as the natural sands.



RECOMMENDATIONS

As a result of these studies, the following recommendations are proposed:

- 1. That the New York State Bituminous Concrete Producers
 Association continue the present study by:
 - (a) An investigation of the feasibility of attaining consistent quality (including gradation) in the production of artificial sands in existing aggregate plants in this state. This study should include equipment and techniques to produce desired and uniform gradations in manufactured sands. The shape and physical structure of the graded particles as well as aggregate classification should be included in this study.
 - (b) An investigation of the relative workabilities of natural sand mixes versus artificial sand mixes.
 - (c) An investigation of the relative skid resistance of natural sand mixes versus artificial sand mixes.
 - (d) An extension of the stability/flow/void testing begun under the present study.
- 2. That the New York State Bituminous Concrete Producers
 Association, the New York State Department of Public
 Works, The Asphalt Institute, and Rensselaer Polytechnic
 Institute jointly sponsor a periodic "short course" in
 asphalt technology for the benefit of plant personnel.



- This short course might consist of five all-day sessions in some off-season part of the year.
- 3. That the New York State Bituminous Concrete Producers
 Association, the New York State Department of Public
 Works, The Asphalt Institute, and Rensselaer Polytechnic
 Institute jointly sponsor a separate "short course" in
 asphalt technology for the benefit of plant inspectors
 and materials engineers from all districts of New York
 State. These men would be made aware of the most recent
 thinking on mix design, the best approach to quality control
 at the plant and on the road. At such meetings recommendations could probably be made which might lead to more uniform
 requirements throughout the state.
- 4. A Research and Development program of the New York State
 Bituminous Concrete Producers Association, Inc. should be
 organized under their control and jurisdiction. This
 program could propose studies of other problems that are
 of common interest to each producer, as well as provide
 advice and counsel for individual problems. Individual
 problems could be solved in a consulting capacity and
 thus could be independently financed.

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APPENDIX A

Evaluation of Questionnaires

Preliminary Investigation



APPENDIX A

The following letter and questionnaire was sent to all of the producer members of the New York State Bituminous Concrete Producers Association on April 5, 1962.

Dear ():

Concerning a study of practices in regard to the materials used in asphaltic concrete being made for the New York Bituminous Concrete Producers Association, we should like your cooperation in gathering certain information.

The basic reason for this study appears to be a variation in the requirements imposed by the District Engineers of the various districts in New York State. We are interested in attempting to analyze these requirements imposed and determine whether or not there are logical reasons for the variation in the type of sand sized aggregate which is allowed.

The first information we must have is just what is the extent of the variations that the producers find exist in the various districts of the State. We would therefore appreciate it if you would fill out and return the enclosed question-naire concerning the practice that you have encountered in doing asphaltic concrete paving in the various district of New York State.

Thank you for your cooperation in this matter.

Very truly yours,

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The following is a tabulation of answers by districts received from 23 questionnaires.

QUESTIONNAIRE

Please indicate the answers to the following three questions in the tabulation below.

- (a) Do you find that sand size aggregate in asphaltic concrete is restricted to only natural sand?
- (b) If the answer to (a) is no, do you find that
 100 per cent substitution of artificial sand is
 permitted?
- (c) If the answer to (b) is no, what per cent of the sand size aggregate is allowed to be artificial sand?

DISTRICT 1

Questionnaire	1 (a)	(b)	(c)	Comments
No.	yes	no	yes	no	% Art.	
1.		x	X		100%	
2.		X	×		100%	
3.		x	x		100%	
4.		x	x		100%	
5.	The second secon	x	x		100%	

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DISTRICT 2

Questionnaire	(a)			(b)		
No.	yes	20	yes	no	MArt.	Comments
1	Annual of the state of the stat	X	x in base	x in top	50%	
3		X		the contract according to the contract of the	100%	We have heard that in certain instances this practice has been modified somewhat.
18		X	ж	**	100% 50%	In base 50% of -1/2" material must be natural sand to increase skid resistance and to make a tougher pavement.
23	de des constitues de la constitue de la consti	X		X	50%	Name of the last o

DISTRICT 3

6		×	x	×	Specs.	gradation equals 52A and 52B.
55	ж	-d/Padpond			Capture Captur	

DISTRICT 4

7	X	x	100%
8	30	x	100%
9	×	×	100%
23	x	x	100%



DISTRICT 5

uestionnaire		a)		(9)			
NO	yes	no	yes	no	MATT.	Comments	
8						Understanding is that 80% natural sand is required in densely graded mixtures. Gradation requirements for Type 2A or 2B fine aggregate cannot be met with artificial sand.	
20	And the second s	x		X.	20%	Item 52 Item 45 SX, 51 52 binder.	
	Table Book Community	X	Z.		100%	e e	

DISTRICT 6

11	X	x	100%
22			

DISTRICT 7

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3	x	Conditional Conditions of Cond			We have heard that in certain instances this practice has been modified somewhat.
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DISTRICT 8

uestionnaire		a) [(b)	(c)	
No.	уев	no	yes	no	Mart.	Comments
1	er (EE) (VEE) fer ver en	en en constantination en			100%	It is my understanding that some plants in Dist. 8 are required to use some Natural.
12	Since	opening	in Ju	ly 194	0 we ha	ve not had occasion to request use of other than Natural Sand.
13	The contraction of the contracti	nde cana canacionemente conscientiame	*;* ~ 25.		100%	Unconfirmed reports say we may have to blend in the future.
14	a participant deligion con transfer del proposition del propos	S. S	er yer eel fa	Control of the Contro	** Characteristic St. Manuscher Princip	Allows use of crushed hardheads.
25	State	x would p	x refer	X lll na	100%	Wearing and top courses. Binder and base courses. and but does permit above.
23	Servicia de la constitución de l	25.		Cimple Lands	50%	Only natural sand can meet gradation.

DISTRICT 9

7.		2		65%	Assume he means 65% natural sand required. Did not check (b) - assume no.
2	Only delete 2: Gircular (2) and Only	The second secon	To the control of the	30%	
3			Remark - Astrija (di Agrigo), da Assagrama, aug	The other of control of the other of the other of the other	We find that our Type A Artificial Sand is effect- ively barred from use in District 9.
14	X		To still question — The state of the state o	30%	District 9 does not allow the use of crushed gravel hardheads.
16		X	A P	30%	
17		x		30%	
18	X			of rate was the figure of the sector	Gradation not sat., with broken limestone natural sand used.



DISTRICT 10

questionnaire	(a)				(0)		
NO a	yes	no	уез	no	MArt.	Comments	
19					100%	Mt. Vernon Plant uses natural sand only. Baldwin, L. I. uses 25% Stone Screenings. We understand other plants on L. I. accomplish same job with 100% artificial sand.	
20	And the Control of th	X.	X	Control of the Contro	100%		



SUMMARY (23 Reports)

- District 1 No problem permits 100% Artificial Sand.
- District 2 Requires 50% in Top course.

 Allows 100% Artificial Sand in base course.
- District 3 Permits 100% Artificial Sand in base.

 Requires 50% Natural Sand in 52A and 52B.
- District 4 No problem permits 100% Artificial Sand.
- District 5 Allows only 20% Artificial Sand in Item 52.

 Allows 100% Artificial Sand in base and binder.

 Statement made that gradation requirements cannot be met for 2A or 2B with Artificial Sand.
- District 6 No problem permits 100% Artificial Sand.

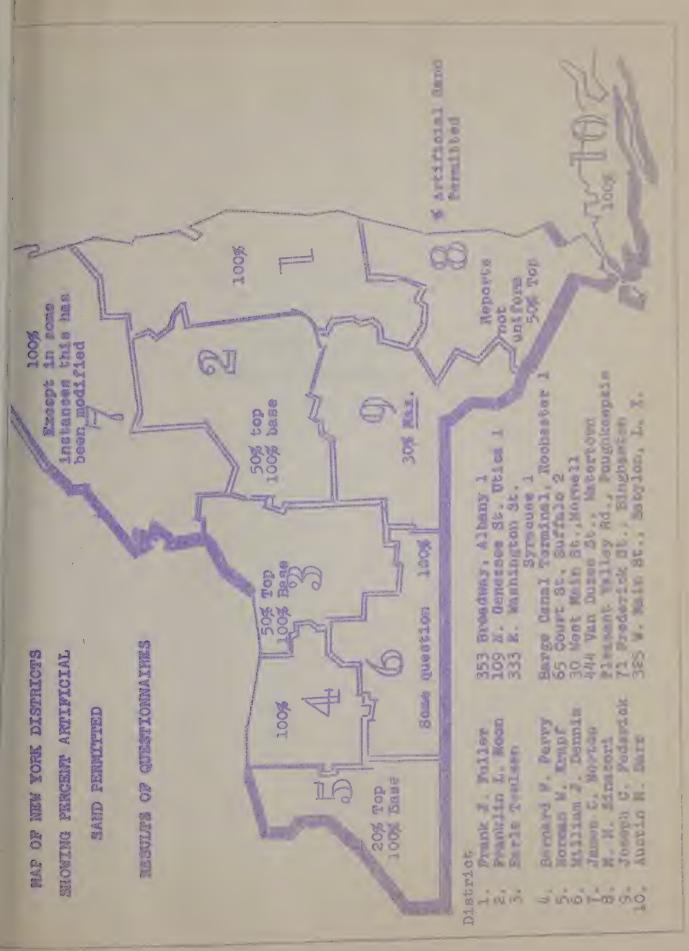
 One report says Natural Sand 100% (22)
- District 7 No problem except hearsay that in some instances this has been modified.
- District 8 Reports not uniform:
 - 3 report 100% Artificial Sand permitted.
 - 1 reports 50% Natural Sand required in top.
 - 1 reports rumor that plants will have to blend in the future.
- District 9 Maximum of 30% Artificial Sand permitted.

 Statement that gradation not satisfactory with

 Artificial Sand.

District 10 - No problem 100% Artificial sand permitted.

- 3 No problem. 100% Artificial Sand allowed
- 3 50% Natural Sand required.
- 1 70% Natural Sand required.
- 1 80% Natural Sand required.
- 2 Seem to be variations.





APPENDIX B
Technical Evaluations



Callanan Road Improvement Company

W. Taler

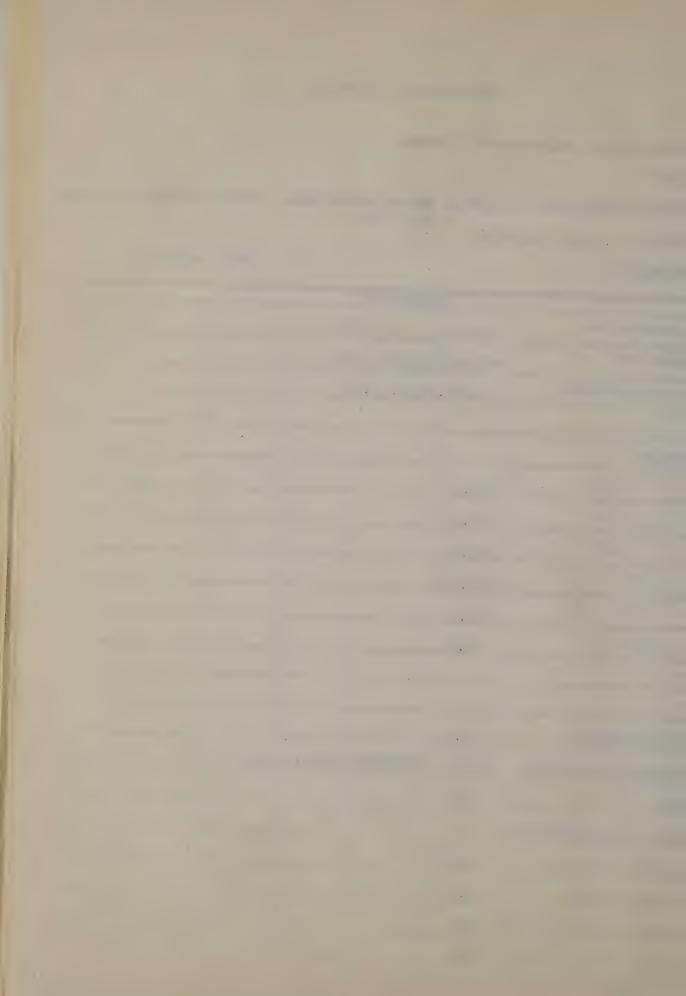
New York 7/12/62

W. Byrd LaPrade

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AGGREGATES & MIXTURES

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Peckhan Industries

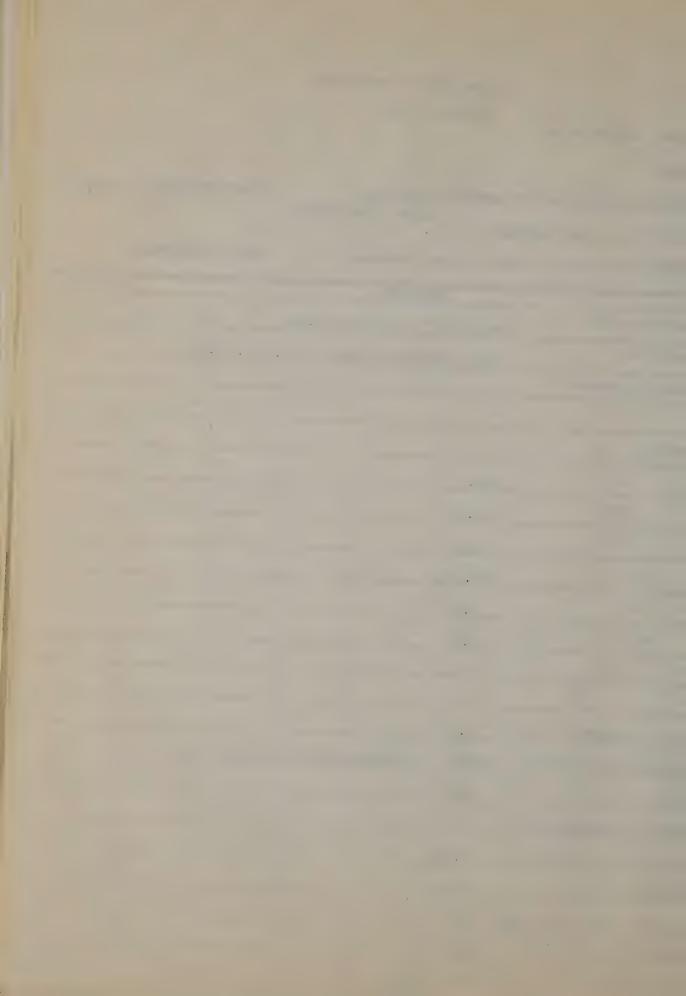
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SOURCE OF LOCATION OF SAMPLE Cold Mix Cairo, New York

TAKEN BY W. Byrd LaPrade

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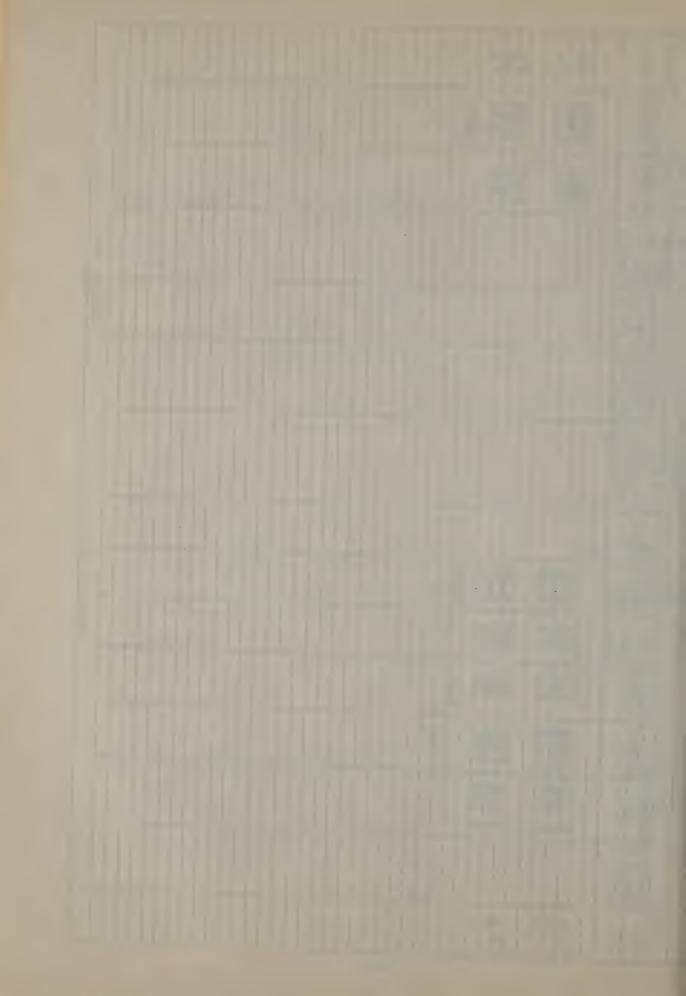
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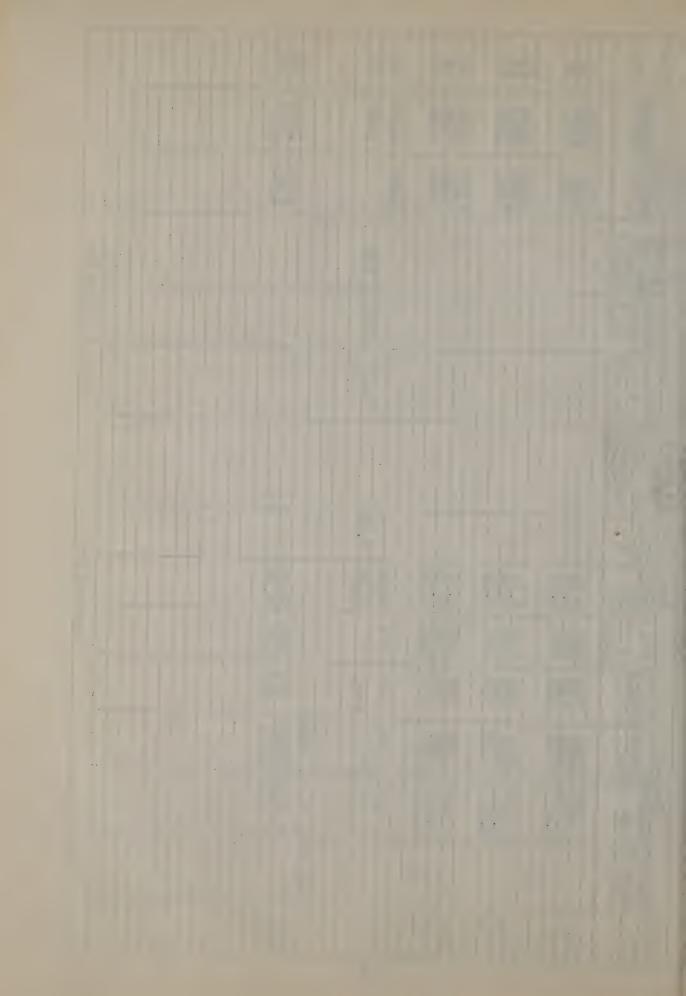
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Additions and an electric control to the control of	The commentation were a supplementation to the supplementation of th	A Strain a versa con a transferencia con a ser e e	a che i a minimizione della comi a spini mente (1275, 1881).	u e se s _e stopse.	to a PL province of the Control of t	- 120078 TAR LEGG, AARDE MAN	Control of the second s	Acres 17 2 folgs
Laboratory No.	1-AC Am	norcoat	Mix N.	Y.	State			
Sample No.	100% Ar	ificial	Sand					
Class Aggregate	Sp. Gr.	2.72	therefore the wildows had been		AND SHOULD USE STEELING		1	
	Per record by Albania 1977/2017 residence	One country)		ar Geography			S. S	
Pacific	ers to the second secon	Vine 1 North Classical in the second	or entra De com	Section Co.	and the property all a hand to record a stay of the stay.	CONTRACTOR CONTRACT		20 12 No 12
\$1. 1/2	100.0	C C					MANAGEMENT WAY	
S I / A control of the second	90.0	Maria and the second se	to the second second second second					
D. J. J. B.	64.2	The second secon			ente try lists data transcription or a	A DOUBLE BY BY BUTTON OF THE		24 366-7 151 X
A TO	33.2		the stay of the transports and the	100 M 100 M	elle, en sleife i Coloni elle elle elle (1845). 201	II) 145 5-1 means re-on the second day	The second secon	
e 80	11.1	SEC. AND STATES CONTROL OF STATES AND STATES	الإدافة المؤدنية المؤدنية المؤدنية المؤدنية المؤدنية المؤدنية	of the Contract of the Contrac	Continues of the second se	ti.		
	3.7	The state was some say that you are not only that	lla (Novinsi) se proprio se persona se pers	against a shirteen at	TANGE STANGED STANGED IN STREET, WITH THE PARTY OF THE PA			wante of
CONTROL COLUMN C	Supplementary of the mass on the made parties. I'm	Signing company of the south of	where the property of the second	10 mm 11 3 m 12 mm 10	one year front the Calle State of the Calledon State of the Called	A The Statement of the Statement and Coloring and Colorin		(Viasor) I
THE STATE OF THE S			Charles Andrew Call Control	The state of the s	makenen cast of Rollins whose so	A CONTRACTOR OF THE CONTRACTOR	And A Section 2 and A section 2	- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1
% of Biture	6.7	(85-100	Pen)	The second secon	processor in all the constitution of the training of the train	AN 1999 To AND AND THE WORLD THE		. 4+4*****
Marshall Stability	1854	Probabl	error	+	55#			
Plos	13	TOTAL COL CONTRACTOR STATE CO.	or come to proceed the second of the second		on the care to published the same to a	is water as a special population of the	Tax man fry	2. 11.
Loss by Decentation	Accommendation where was a 10 20 of the COLD.	The state of the s	1887 P. Star Van De waren John St. St.		ada, di sene e si fai fai talenni, ma e fai dale		L. San Carlo	
Specific Gravity	2.36	2 . The the second second	The ter of Desiration was a		and the standard of the parties of	CONTRACTOR DESCRIPTION	2000	
Percent Voids	4.0	11.00 Al 1 1 1 1 1 1	the sign was treple to the t		or the contract of the contrac	Jan. 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,		
Persont Void: Filled			an I have been put Mary tons a		State of the State		2	
Weight Per Co. Ju	147	5/52 . 2 / 0 . 15					30 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
Modethine		B-7		4				



	F/0W	200	0 = 10	alaa	2 2	a c	
	Converted	2720	22200	0.000	1340	1610	
124.0	Stabili Nessured	1710	1420	1330	3	1550	
	Carl Mix 50101 Mix 6x 624						d by:
TIRES	That				78		Checked
ASPHALT MIXTURES	Voids -				0.4		
One end.	40 by Vol. 3 B Spier. of						
1 7 -					Ta co		•••
ATION OF	Sp. 6	See See	2000 2000	2000	50 00 00 00 00 00 00 00 00 00 00 00 00 0	2.39	Computed by:
СОМРИТА	Vol.	401 401 401	%25 25 25 25 25 25 25 25 25 25 25 25 25 2	7.75 7.75 7.75	700	9877	Comp
	Grams. In Warer	2012	1300 FC 601 FC 6	75 25 7 72 12 7	Avg.	673	
- t- c-	117	122 100 100 100 100 100 100 100 100 100	250	700		Stat. 1159 1165	
Project.	Thickness III	25.1/2	100	2 1/c 2 0 1 3 13/16	3 7/8	2 7/16 2 7/16 2 7/16	
	Asphalt Coments					T T T T T T T T T T T T T T T T T T T	
Tob No.	speci-	A T U	A E C	M SICI	4 7		



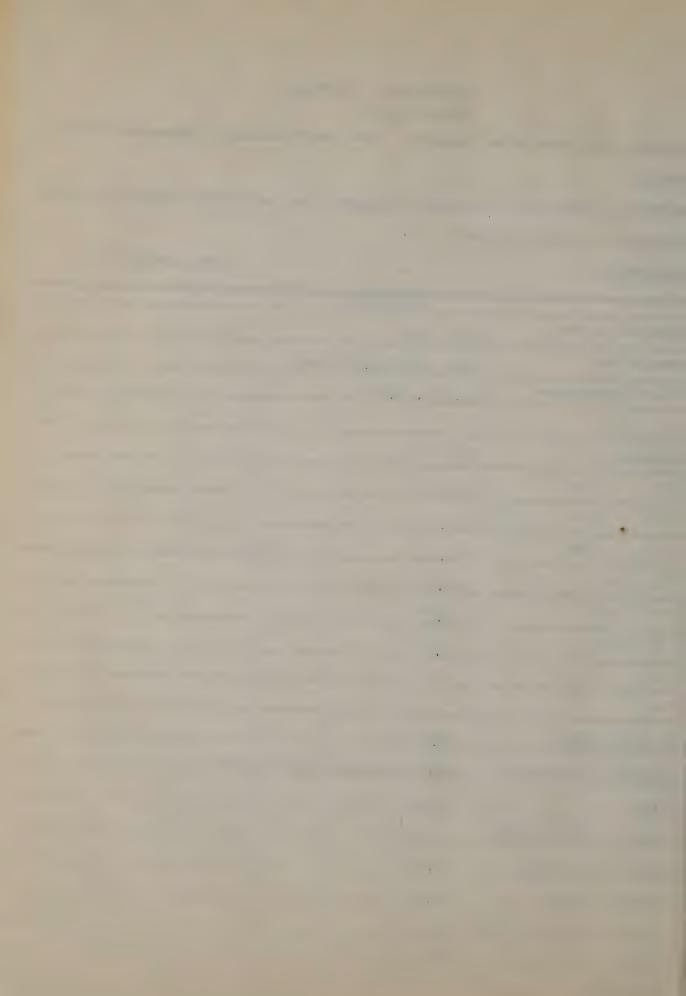
District #2

Eastern Rock Products Company 404 Court Street, Utica, New York

TAKEN BY W. Byrd LaPrade

REPORTED TO

The Committee of the Co	AMALYSIS
Laboratory No.	1-AC Mix
Saugia No.	100% Artificial Sand
Class Aggregate	Sp. Gr. 2.69
ACTUAL CONTRACTOR CONT	
Pacaing 1	100.0
St 1/2	99.7
1/4	99.4
1/8	55.0
, 50	15.5
* 80	9.7
8 500	6.3
The second secon	
% of Bitchen	6.7
Marshell Stability	1630 Probable error + 50#
710%	12
Loss by Decantation	
Specific Orawity	2.31
Percent Voide	4.6
Percent Voids fille	d 77
Walght Far Co. Rt.	144
SG1.FTUEN	



	Jow 0	alala	100	MMH.	aam	22	
	210 - 710 J	1920 1830 1730	1470 1700 1710	1480 1780	15000 15000	1630	
4	Stability	1610 1500 1450	1350 1700 1660	1480 1480	1820		
	Can Mix Colal Mix Gx G24					工体件	bys
MTYTHIRES	That of					76.8	Checked by:
ASPHALT MTY	Voids - 7					9.17	
One	Since of						
1 124	120 V					97°	**
ATTON OF	So. G	STORES	m a a	2000	0000 0000	E.3	puted by:
COMPUTA	Vol.	1277	473 510 181	100 100 100 100 100 100 100 100 100 100	186 187 529		Comp
	Grams In Water	500 500 500 500 500 500 500 500 500 500	625 662 662 662 662	500 to 50	5255 527 527 527 527 527 527 527 527 527	AVE.	
-	181	10053	1098	1043	1025		
-	Thickness with	2 3/1	2000	2/18 2/18 2/18 2/18 2/18	2 3/16		
	Asphalt 6						
	Job No.	A MO	S A	M M C	4E 0		



District #2

Eastern Rock Products Company 404 Court Street, Utica, New York

PROJECT

SOURCE OR LOCATION OF SAMPLE Fort Herkimer, N.Y. DATE RECEIVED 7/3/62

TAKEN BY W. Byrd LaPrade

REFORTED TO

		10/0/318
Laboratory No.	1-AC Mi	x N. Y. State
Sample No.	Less was to face to expect the arts - Title .	Aggregate 2.69
Class Aggregate	1	Sand, Sp. Gr. 2.67
TOTAL TOTAL CONTINUES OF THE STATE OF THE ST	TOTAL SAN	
Fresing 1 %	100.0	
N 1/2	93.8	
N 3/4	87.8	
D 3/8	55.5	
FI AND SOLD SOLD SOLD SOLD SOLD SOLD SOLD SOL	29.1	50% Artificial Sand
80 Son	9.0	
* 500	4.9	
		as an equation and the second particles and the second second second second second second second second second
TO SOME BOOK AS THE STREET WAS THE TO SOME AND ASSAULT OF THE COMPANIES OF THE SOME SOME SOME SOME SOME SOME SOME SOM	The same of the sa	AND THE PROPERTY AND ADDRESS OF THE PROPERTY ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY ADDRESS OF TH
% of Miteso	6.2	and the first and the second of the second o
Marsball Stability	2100	Probable error + 50#
Flow	17	
Loss by Decantation		
Specific Orneity	2.40	
Percent Tolda	1.8	
Percent Voids filled	89	
SALDA PER CAL PL.	150	
Roisture		and the second s



	F10W	200 K	0000	G 2000	T. DOGO		
	Converte	1950 2120 2320	2300 2250 2420	2410 1358 2178	1930 1680 1670	0012	
	Stability A	1950 2370 2140	2300 2520 2520	2330 1950 1640	1850 1410 1260		
	Charl Mix Tolal Mix Gx G24					120	l by:
MTYTHIRES	A That					D)	Checked by:
ASPHALT WIT	Voi ds -						
6	AC by Sperior of Best of Sperior						
1	Description Sp. Gr.					2.45	99
ATTON OF	Descr Sp. C	2.40	2 40	07 001	80 0 C	2.40	Computed by:
COMPUT	Vol.	505 540 184	5133	420 120 120 120	4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Comp
	Grams, In Water	683	712 681 735	684 597 597	11.667 0.0000 0.00	AVE	
	17	1201 1292 1166	1225 1165 1259	1172	1172		
-	Thickness with	2/2/2	2 1/2 5 2/16	2 7/16	2 7/16		
	Asphalt Coments						
	Job No.	T B D	2 A B C	W MC	420		



District #2

Eastern Rock Products Company 404 Court Street, Utica, N. Y.

PROJECT

SOURCE OR LOCATION OF SAMPLE Oriskany Falls, N.Y.DALL BELLEVICE 7/2/62

TAKEN BY W. Byrd Lafrade

REPORTED TO

Proceedings of the state of the	Samuel to the state of the	MALYSIS	
Leboratory No.	l-A Mix		
Sample Bo.	Class 1		equato con un a a monte a como a monte o como a como como como como como como
Class aggregate	5	Agg. 2.69	The same are the same as a second sec
Annual of the demandation of the contract of t	Sp. Gr.	Sand 2.67	
Passing 1 %	100.0		
H 1/2	99.4		
1/4	77.3		
n 1/8	47.4		
, 50	22.0	50% Artificial Sand	
* 80	6.7		TO THE REAL PROPERTY OF THE PERTY OF THE PER
a 500-	3.8		
	AND THE PERSON NAMED ASSESSMENT		and a manufacture of the first first and the first fir
Miles	The second seconds are a second		Can post de
% of Bitumen	6.3	and the state of t	and the same of th
Maraball Stability	1510	Probable error 35#	
Plos	17		Constitution of the second second
loss by Decastation	The state of the s		
Specific Gravity	2.38		The state of the s
Parcent Voids	2.3		
Percent Taids fills:	86.5		
Walght Far Co. Tt.	148.5		
Relature			



	F/000	7-89	133	MAT M	엄컴	₽	
	Conversa	1280 1420 1730	1,760	1570	1630 1250 1210	1510	
-	State 11	1380 1420 1450	1340	1440 1250 1180	1370		
	6x 624					148.5	d by:
MTYTHIRES	1/4-07					6.08	Checked
A SPHALT MTX	Voids - 1					2.3	
FES OF	of blends he by your						
F PROP	Description Sp. Sr.						••
ATTON OF	Sp. C	2000	222	minin ninin	2000 2000 2000 2000	<u>ू</u>	Computed by:
COMPUTA	Vol	7552	439.75	473	127		Сом
	Grams	6833 6833 612	181	5775	623 647 563	AVE.	
	11	1248 1052	1062 1342 1053	1121	1080		
	Thickness 12	1200 1200 1200 1200 1200 1200 1200 1200	3/10	2000	25.5		
	Asphalt Convit 10						
	Job No:	AMO	N N N	m 0	4 883		



Eastern Rock AGGREGATES & HINTORES District #2

PROJECT

SOURCE OR LOCATION Oriskany Falls, New York

TAKEN BYW. Byrd LaPrade

DATE RECEIVED 7/2/62

REPORTED TO

DATE REPORTED

	Ā	HALYSIS				
Laboratory No.	1-AC arm	or coat	New Yor	k State		
Class Aggregate	50% Natu	ral Sand	Clas	s B Sand	Sp. Gr	. agg. 2.69
Fassing %					Sp. Gr	. Sand 2.6
n 1						Appropriate National Designment Internal Confession (Confession Confession Co
" 1/2	1,00,0					postario de la companio de la compa La companio de la companio della companio del
1/4	75.2					The state of the s
1/8	46.0					ton Annual No Pitrik Mill (2014 abbots a sci-fillate) All (4-70) abrush ti ureb
n 20	27.2			Name and the second of the sec		#Philipping and project in the state of the
" 40	16.4	50% Ar	cificial	Sand	-	general des (All Magazine des (All Magazine) des (All All All All All All All All All Al
# 80	8.0		, (acques agrana d'Alba-a, Adreption) «Talqui Girgi)	PALIFY AND PARTY AND THE PARTY STATES OF STATE	Managara Caranta Caran	positical timper year military consensation Huncury 2 MAZAS AN
# 200 	3.9	La company de la	ere variables egangen and supplier of the property of the prop	grazingani (19. Pipit re-reprinsi proprint little filozofia.	AND CONTRACT OF THE PROPERTY O	OFFILE PROBLEMONTAL STREETS AND A VENTURE OF SHEET OF
Penetration		To the second	The second secon	THE LOCAL COMPANY OF LOCAL PROPERTY OF THE PARTY OF THE P	Committee to the control to before the control to t	defination and a subset of the second state of
6 TO THE THE CONTROL OF BUILDING THE STATE OF THE STATE O		The Commentation Control of Louis A., 152-	arough Actuatives and head of a continuo designation of the continuo designation of th	CONTRACTOR OF A SERVICE OF A TOTAL ASSESSMENT OF A SERVICE OF A SERVIC		
		A CONTRACTOR AND A CONT				pagastamon o constitui de la c
Market and the control of the contro	and a second of the second of		grade consequencia del mala consequencia del esta del consequencia del con	ys gol Grago de de constante en pagas propagativas est a pagas.	Libraria, Concession Scotton Pro-, Toxoloristico	The simulate restriction was a substance of the source of
Control of the state of the sta	and the state of t			1965 - Darly Berlin, all I I class and restored a consequentions	enter-el a el tempo qualitza del terro del terro de la companya del del terro del terro del terro del terro de	সভাবে কামানিবিক্তাবাহিত্যালয়কার্যাকার কামিনিব্রে ও ৮০০% চনন । ১৩ সঞ্চান্দর্য
Avarage Penetration	The same distribution property distributes to print a stable in	AND CONTRACTOR CONTRACTOR AT THE STATE OF		danishes (- 2 to all 4000 and the control of the c	Average	риник (Компония на напочина на применения н
8 of Bitumen	17. 3. 3. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	The second secon	The State of the S		Average	* Sitting of the construction and an additional section of the construction of the con
Marshall Stability	1800	F109	19	Probable	error	55#
Specific Gravity	2.39				п.д. парагогия	
Percent Voids	5%	BARTER BOOK OF THE AND	A CONTRACTOR OF THE SAME			and the second s
Percent Voids filled	979	The second secon	A REPORT OF AN AUTOMORPHICA	MALL TOTAL OF BRIDGE COURSES A SECTION OF	t t the January of the source or ordinary to anything	manufactures, one extraction of the tracks, who manufactures
Weight per cu. ft	149			Participation of the Associated Wiles Associated	COV	in page 1845 for the Color on proceed tradition
Moisture in subbase		A Application of the Control of the			4	
The Communication Communication and Communication Communic	MARKET PROPERTY AND CONTRACTOR AND C					

REMARKS:



	F10w	22022	1000	920		57	
	Converted	1680 22040 22040	2200 1750 2210	1800	1200	1800	
12+00	Stabili Neusured	1750 1960 2120	1750	1740	1080		
	Cant Wix 50,001 Wix Gx G24					146	d by:
MIYTHERS	THE					6	Checked
SPHALT MT	Voi ds//00-100/4						
PROPERTIES OF AS	by Spenigh						
<u></u>	* 78 3					2° to	90
Descri	20.00	000 T	0000 1000	000 000	2000	SE 23	Computed by:
COMPUTA	Vol.	44.00	456	444	450		Comp
	Grams, IN MATER	00000	654 709 608	2000 2000 3000	029	SO A A SO	
1	1181	0000	1220	1044	1058 1069 1042		
Project	Thick	2 9/16	2 2/10	0000 0000	77.00		
	Asphalt Conent 16						
TON NO.	Speci-	4 20	N M D	M dro	4 A		



District #4

Rochester Asphalt Materials, Inc.

PROJECT

SOURCE OR LOCATION OF SAMPLE Penfield, New York DATE RECEIVED 8/16/62

TAKEN BY W. Byrd LaPrade

REPORTED TO

DATE REPORTED

	The state of the s	WALL BUILD
Laboratory No.	The second secon	
	1-A Mix	2 h manufactur (Charles (Charl
Saaple No.		Sp. Gr. Agg. 2.66
Class Aggregate		Sp. Gr. Sand 2.66
Passing	S of Programming States	50% Bank Sand
" 1/2	100.0	31.3 50% Crushed Dolomite
1 2/4	68.7	31.2 Sand
1/8	37.5	17.8
A 20	19.7	9.4
80	10.3	6.7
a 200	3.6	3.6
	E Aux man (united that however) should show the control of the con	The second street of the contract of the contr
TO THE SECOND STATE OF THE	The second section of the secti	and the control of th
of Bitumen	6.7	TO THE RESIDENCE OF THE PROPERTY THE THREE AND A SECRETARY WHICH AND A SECRETARY WAS A SECRETARY TO SECRETARY THE PROPERTY OF
Aarshall Stability	1664	
Plots	24	AND ALL SHOP THE LOCAL SECTION AND AND AND AND AND AND AND AND AND AN
Loss by Decembration		
Opecifie Gravity	2,46	A CONTRACT OF THE PROPERTY OF
Percent Voids	1,2	
Percent Voids fille	ì	
Weight Per Cu. Ft.	153.5	
Molature	B-17	

B-17



mo/-	21 10 10 10 10 10 10 10 10 10 10 10 10 10	#22	1
	Make Make	20	
Converted	1480	1665	
12+03 Stabij 13 Nessored	1700 1760 1860 1540 1758		
Con Wix 500 Wix 6x 624		153.5	by:
1		70	Checked by:
OR ASPHALT MIYMURES		1.2	
	88 885		
From the on the one		2.48	••
Descrip	144 F	5,46	Computed by:
Vol.	424 H		Comp
Grams	752 782 783 783 783 783 783 783 783 783 783 783	Ave	
17	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
Project:	1000 0000 1000 0000		
Aspha/7 16	IX N X		
Job No:	A A B D A MD		



J. P. Baker, Supt.
Bituminous Products, Inc.
Plant #1, 500 Como Park Boulevard

SOURCE OR LOCATION OF SAMPLEBUFFALO 25, New YorkDate HEGELVED

TAREN BY W. Byrd LaPrade

REFORMED TO

	The second secon	MALVELS
Laboratory No.	1-A Mix	New York State
Sample No.	£	m Buffalo Slag Sp. Gr. Stone 2.69
Class Aggrerates		
THE PROPERTY OF THE PROPERTY O	1-A	1-AC
Passing	A STATE OF THE STA	50% blend Natural Sand Franklinville Plant
11/2	100.0	100.0
S The second sec	78.4	98.0
7 3/8	45.8	57.0
	19.0	30.1
	8,9	10.7
n 200	5.0	6.1
\$5.	Towns Comments of the Comment of the Comments	Management of the state of the
P		
% of Bitumen	7.0+	7.0 ±
Marshell Steellity	1468	1715
Plow Plow Property and the second control of the Co	23	19
Loss by Decementation		
Specific deseits	2.37	2.35
Percent Voids	1.7	2.5
Percent Voids filled	89.5	85.7
colgat For Du. Ft.	148	146.5
Molaburn		
Moisturn	1	3–10



	F10W	Sala	25.2	22 22	22.5		222		6	
	Converse	1255	15.30	1455	1468		1110 1400 1500 1500	2000 1770 1920	17.15	
_	Stabili Messared	1350	1530	1220			1400	1840 1760 1760		
	Carl Mix 5061 Mix 6x 624				148				146.5	l by:
MIYTHIRES	K THI				89.5				85.7	Checked
ASPHALT MTY	Voi ds - 1				T. T				2.5	
OID	AC by Vor - S	505	0000	500			000	0000		
174	Sp. Gr.				2.41				2,41	••
ATTON O	Descr Sp. C	2.36	2000	2000	2.37		2000	NNIN NNIN	2.33	Computed by:
COMPUT	Vol.	222	47.70 47.20	443			4500	44 44 480 480 480		Comp
	Grams,	102	123	611 628 628	A V.B.		200 704 647	0000	AVE.	
	THO THE	1223	1208 1242 1148	1055			11223	11.46		
er a	Project:	2000	2 3/2 2 3/2	2 3/4			2 1/2	2 3/8 2 3/8 2 3/8		
	Asphalt Commit 16	N. N.				XI				
	210		N N	4 mo		1-AC	Z MU	NACO		



District #6

A. L. Blades & Sons

PROJECT

SOURCE OR LOCATION OF SAMPLE Webb's Crossing DATE RECEIVED 8/8/62 Hornell, New York

TAKEN BY W. Byrd LaPrade

REPORTED TO

	TO STATE OF THE STATE OF THE PARTY OF THE STATE OF THE ST	Charles of the Control of the Contro
Laboratory No.		
	A PROPERTY OF THE OWNER TO THE STATE OF THE PROPERTY OF THE PR	BOOGNATION DI NOON ANAMENT MANAMENT ME MENTENDE ME ME MANAMENT DE MONTH MANAMENT DE MONTH MANAMENT DE MONTH ME
SANDIG NO.	1-A State Top	TO EXTENSION ANY SIME PROPERTY LINEAGE TO THE STATE OF TH
Class Aggregate	100% Natural Sand	And the section of th
enterente de la companya de la comp	The second secon	Addistribution of the contract
Passing	CONTRACTOR CONTRACTOR AND THE CONTRACTOR OF THE PARTY NAME OF THE	
1/2	100.0	
n 3/4	81,2	
n 1/8	57.3	The second secon
4 50	30.4	ACTIVITY REAL PLANT AND ACTIVITY SHAPE AND ACTIVITY ACTIV
80	8.2	City and monthly are state, all the good if double a state of the stat
19 200	5.5	Sanctual Charge growth 1876 - String in Englisher was a classification and a contract of the c
The state of the s	Constitution of the State of S	auch CRISTINE FIG. ANTHE EMBREAD REACHES CONTRACT AND AN ACTIVITIES AND AN ACTIVITIES AND AN ACTIVITIES AND ACT
M.	Springer in Relating on control of the Control of t	
6 of Bitumen	6.6	and Wilder
Marshall Stability	1615	To the second se
Plow	14	
Loss by Desantation	The state of the s	
Specific Gravity	2.36	And and the Chanded company of the State of the Chanded State of the Cha
Percent Voids	2.5	ELOCACIONES ESTA CONTRA CO
Percent Voids filled		The first of the state of the same of the
delight Per Cu. Pt	147	and a crising print them in the control to the first and respectively. All the control to the co
to the Coal to a second of the second of the second of the second	The state of the second	at the platforman of the statement of th



IT						11	11		i	11	П		
	F10W	222	cumm Heleri	14									
	Converte	1635	1580	1615									
100	Stabili Neasured	1,000 1,000 1,000 1,000	1520										
	Cail Mix Tolal Mix Gx G24			147									by:
TIPES	Try C			100									Checked by:
ASPHALT MIYTURES	Voids - 1			2.2									
PROPERTIES OF AS	199												
PROP	50. Gr.			2,42									••
COMPUTATION OF	Sp. G	2000	000 000	2.30									Computed by:
TOMPUT	Vol.	2223	2557										Comp
	Grams Za Water	(30	673 708 641	AVE.									
-	1171	1269	1232										
	Project;	2 3/4	2 3/8										
	Asphalt Cement 16												
	Job No. Speci-	4 20	N N		-22								



AGGREGATES & MIXTURES District #7

General Crushed Stone

PROJECT

SOURCE OR LOCATION OF SAMPLE Watertown, New Yorkpats RECEIVED 8/9/62

TAKEN BY W. Byrd LaPrade

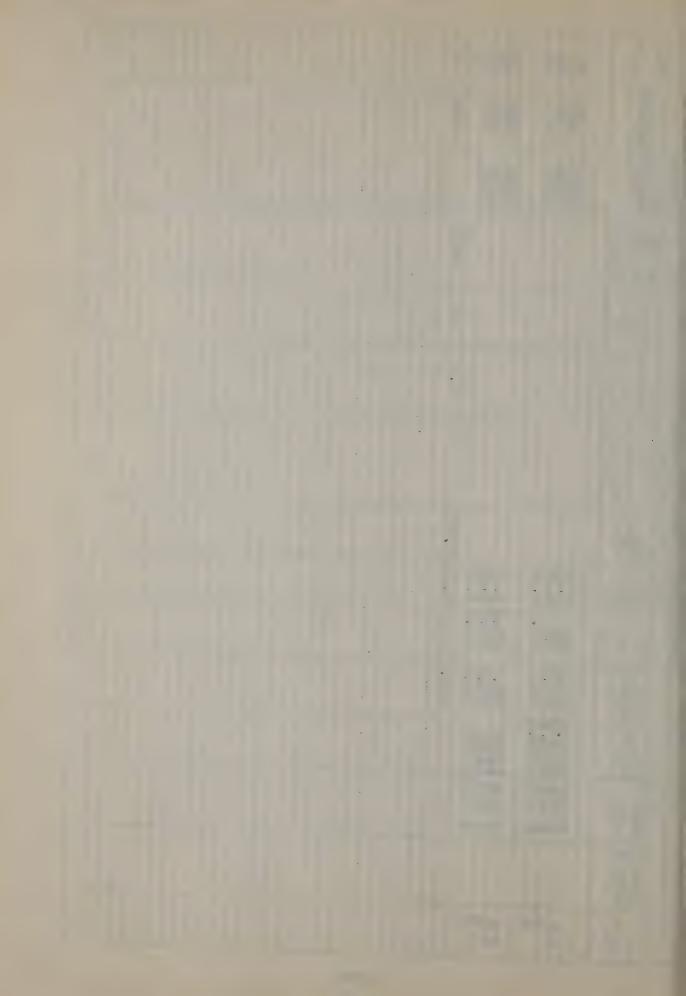
REPORTED TO

DATE REPORTED

Trees with our wa		DATE REPURTED
PROFESSION OF THE PROFESSION O		
Laboratory No.		The state of the s
Sample Ho.	1-AC Armor Coat New Y	Mork State
Class Aggregate	and the second particular properties and the second particular and the second s	The Control of the Co
		CONTROL CONTRO
Passing	Authorities and the second	THE PROPERTY OF THE STATE OF TH
и 1/2	100.0	each is an an address that and a graph of the real and
n 1/4	95.4	
n 1/8	50.3	S. C.
" SO	23.5	
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Current Literature



SKID RESISTANCE

Skid Resistance. The physical characteristics of aggregates vary considerably; perhaps the hardness factor is the most important. A limestone, being a sedimentary rock, has a hardness of 3 in Mohr's hardness scale. A natural sand, being predominately quartz, will have a hardness of 7. This is quite relevant to the polishing characteristics of the aggregate; and consequently, affects the skid coefficient. Limestone dust can be a problem as it is practically impossible to remove. Although most of this is used as mineral filler, it is difficult to control by percent of mix.

Summary of Skid Coefficient by Major Aggregate Types 2

(Pavement Wet, 40 mph)

Aggregate Type	No. of Sources	No.	Range	Average
Limestone (Dolomite)	* 26	1238	.1662	.369
Siliceous Gravel*	2	34	.4352	.474
Trap Rocks (Diabase)	2	The sale of	.3559	.476
Granites*	4	114	.4368	.525
Coarse Sand**	9	270	.4672	.573
Fine Sand***	δ		,5385	.674

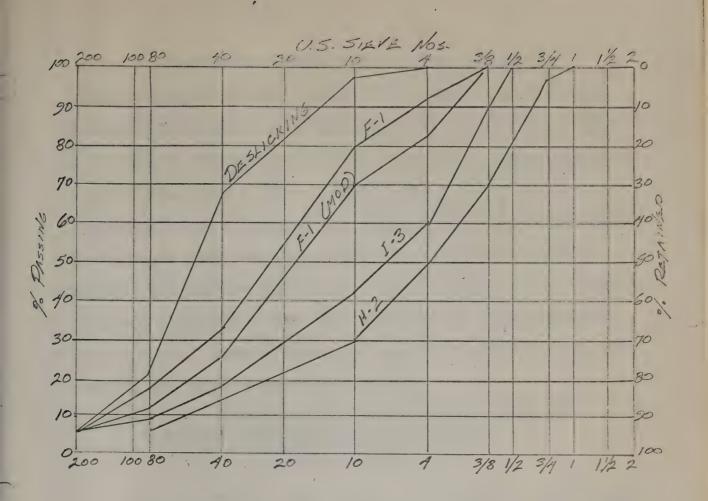
^{*}As found in I-3 and H-2 mixes or Mixed-in-place treatments. **As found in F-1 mixes

^{***}As found in deslicking mixes. (See Figure 1).

^{1 &}quot;Relative Skid Resistance of Pavaments Surfaces based on Michigan's Experience", by E. A. Finney and M. G. Brown. pg. 439

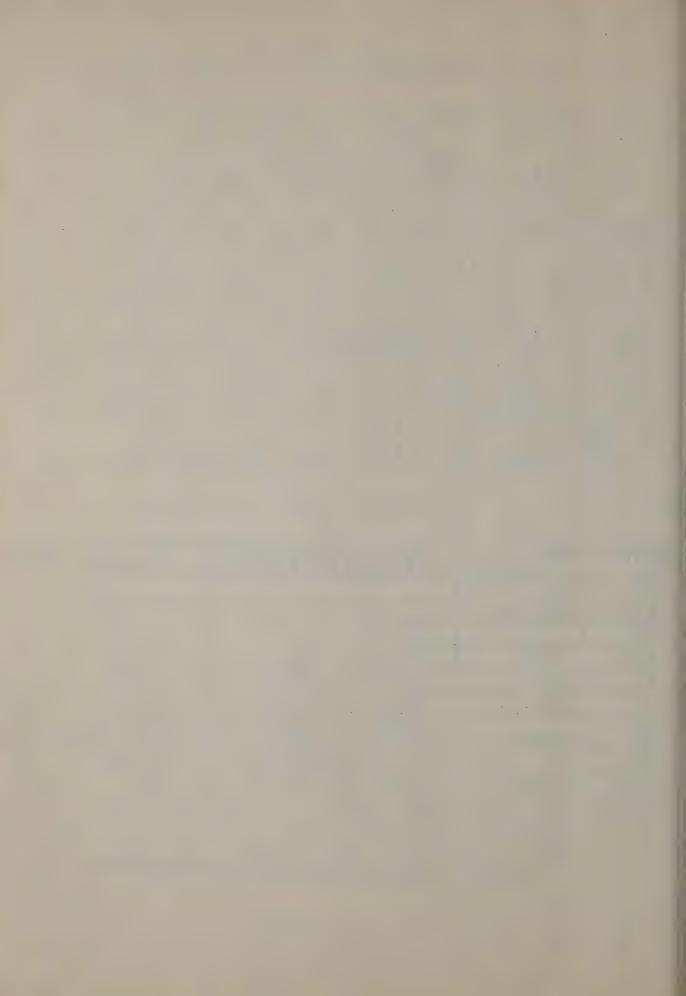
^{2 &}quot;Further Studies of Skid Resistance of Virginia Pavements", by F. P. Michols, Jr.

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				1	
SIEVE	H-2	1-3	F-1 (MOD.)	F-1	DESLICKIN
NO.	% PASSING	% PASSING	% PASSING	% PASSING	% PASSING
1"/ "	100				
3/4"	95-100				
1/2"		100			
3/8"	.60-80	80-100	100	100	
4	40-60	50-70	75-90	85-100	100
10	20-40	35-50	60-80	65-95	95-100
40		10-25	15-35	20-45	40-95
80	3-10	3-15	5-15	5-30	12-30
200		2-10	2-10	2-10	2-8
APPROX AC.	5.0%	6.2%	7.0%	7.2%	8.0%

Figure 1. Typical Virginia plant mix gradings.



Conclusions drawn from this report are that slippery pavements will develop from aggregates which are susceptible to polishing, regardless of the texture. This was based on the principle that a dense sand paper textured surface will hold a film of water, and high speed traffic tires will have a tendency to aquaplane. On the other hand, a coarse or open mix will allow the heavy rain to drain between the surface aggregate. In 1954 resurfacing contracts required that 50% of the fine aggregate be a non-polishing silica sand. Some of these ran up to 100% silica sand. The results are shown below in Table III.

TABLE III. RESULTS OF STOPPING DISTANCE TESTS ON 1-3 MIXES CONTAINING POLISH-RESISTANT FINE AGGREGATE, LAID IN 1954 (Pavement Wet, 40 mph)

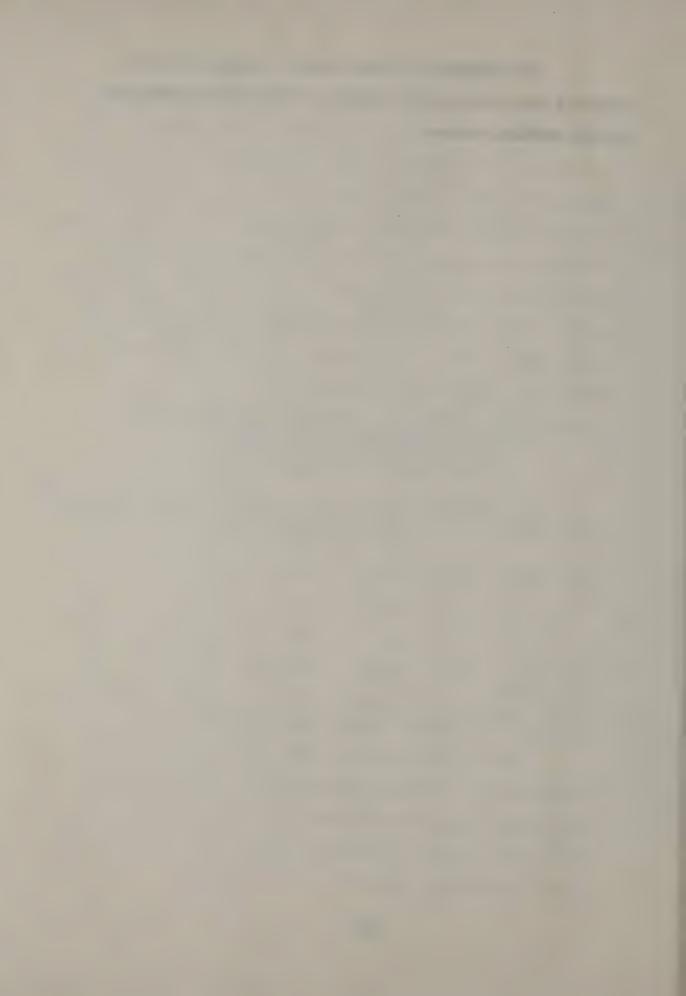
Route	County	Traffic* VPD	% Sand	9 months	Stopping Di 24 months	stance, Feet 48 months
			0	102	128	101
21	Wythe	1150	20-25	93	135	107
			40-50	99	132	97
			0	123	144	125
33	Rock-	3500	20-25	109	136	107
atheristration according to complete contacts	ingham		40-50	110	126	110

^{*}Average daily traffic fiscal year 1957-58.

As can be seen from Table III, little benefit was gained from adding polish resistant fine aggregate.

"The factor which seems to have the greatest effect on slipperiness of wet pavements, then, is the aggregate with which a pavement is built."

As a result of these tests, Virginia will no longer allow the use of limestone or dolomite aggregates in the surface course.



RESULTS OF TRIAL MIXES

In This report by P. A. Wedding & R. D. Gaynor, an overall picture of the affect of aggregate particle shape was investigated. Variations in asphalt content, aggregate grading, percent crushed particles in the coarse aggregate and types of sand (natural or crushed) were analyzed. For our purposes, only the later variation at optimum asphalt content were extracted from the report. Figure 2 shows the gradations used on these trial mixes. Quartzite gravel was used for natural and crushed aggregate and sand sizes. The apparent specific gravities were the same 2.66 for each size and type. Therefore, particle shape was the only variable here. The results are plotted in Figure 3.

Stability. Stability was substantially higher for the crushed sand condition and not too high to produce a semi-rigid condition. This is significant in that the densities are generally lower for the crushed sand. This is an evidence of better keying in the sand sizes.

Void Content, The void content is higher for the natural sands but not significantly so; and only occurs with the 35% sand ratio. This small variation shows little affect between the two sands.

^{1 &}quot;The Effect of Using Crushed Gravel as the Coarse and Fine Aggregate in Dense Graded Bituminous Mixtures", by P. A. Wedding & P. D. Gaynor AAPT Vol. 30, 1961, pg. 469

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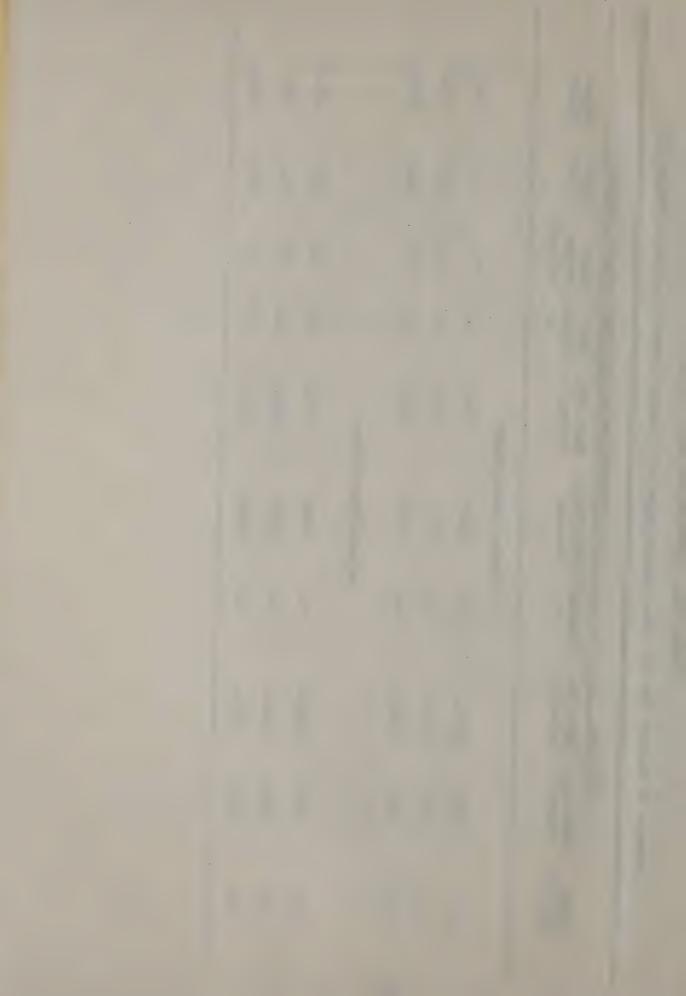
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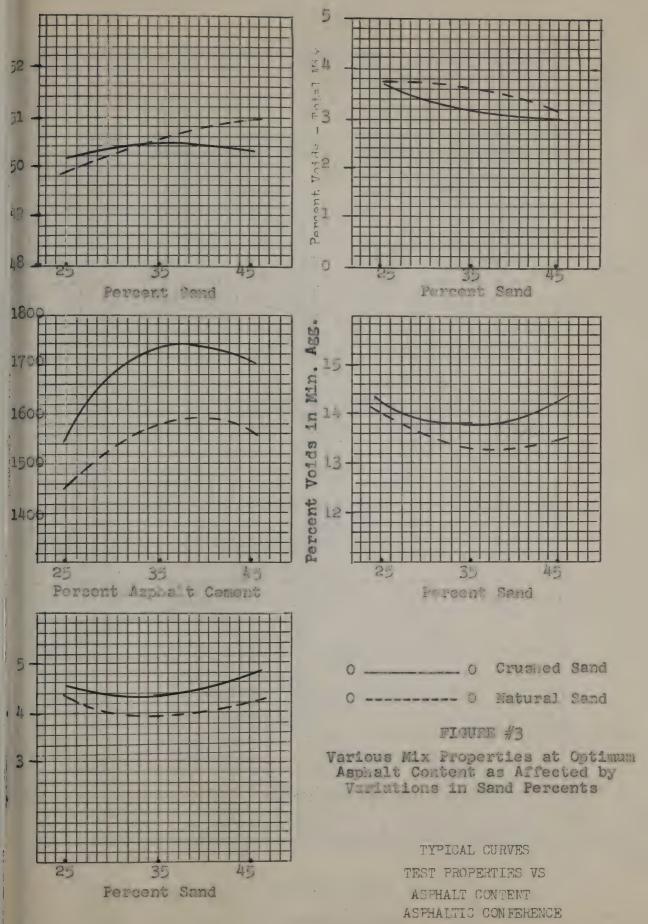
Unit Weight. The unit weight was not significantly higher for the natural sands which usually runs parallel with Marahall Stability. This similarity in unit weight and difference in Marshall Stability is a very definite comparison of the two sands. The natural sands having the higher unit weight show their ability to compact into a more denser state than the artificial sands. This is related to the particle structure, the natural sands being more rounded will flow more readily than an angular particle. This could be termed a more workable condition.

TABLE VIII SUMMARY OF TEST RESULTS

Average of Values for the Four Percentages of Crushed Gravel Listed in Table IX

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Mix Properties	Stability	Crushed Sand N	1530	1730	25	Neturel Sand P	1450	8	2550
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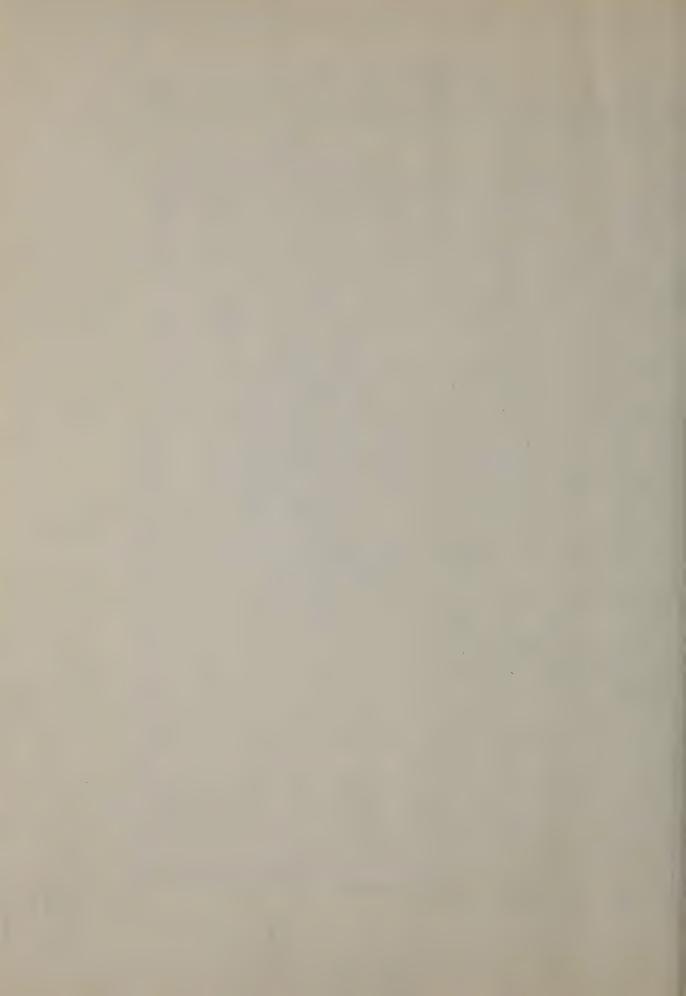






PER CENT RETAINED 20 80 30 20 U.S. T 2 2 DISTRICT DRAWN 12-21/3 SOURCE NO. 1001 0 90 2 09 80 50 PER CENT PASSING FIGURE #2

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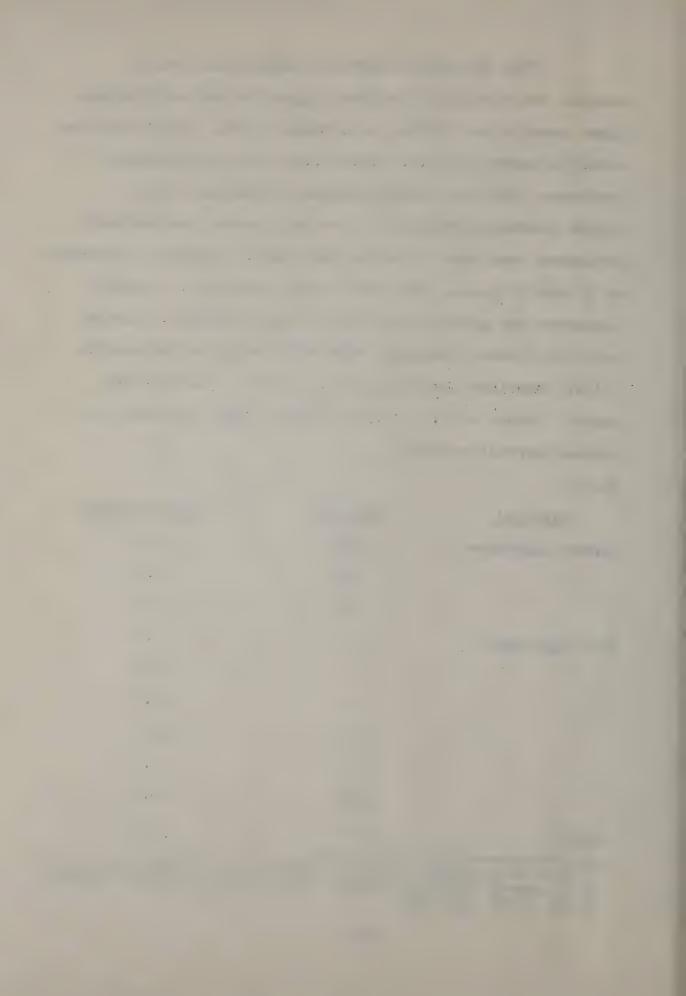


The trianial-compression method was used to measure the strength of various aggregate and combinations. These results are plotted as straight lines. Mohr's rupture envelope appears to be a curved line with low confining pressures, but practically assumes a straight line at higher confining pressures. For this reason, no confining pressures less than 15 p.s.i. were used. Confining pressures of 15 and 45 p.s.i. were used on the dense mix. Crushed limestone and gravel were used as the aggregates. Natural sand and crushed limestone sand with cement as the mineral filler comprised the fine sizes. A 60 - 70 penetration asphalt cement at 6.0 - 5.5% of total weight was used as optimum asphalt content.

TABLE I

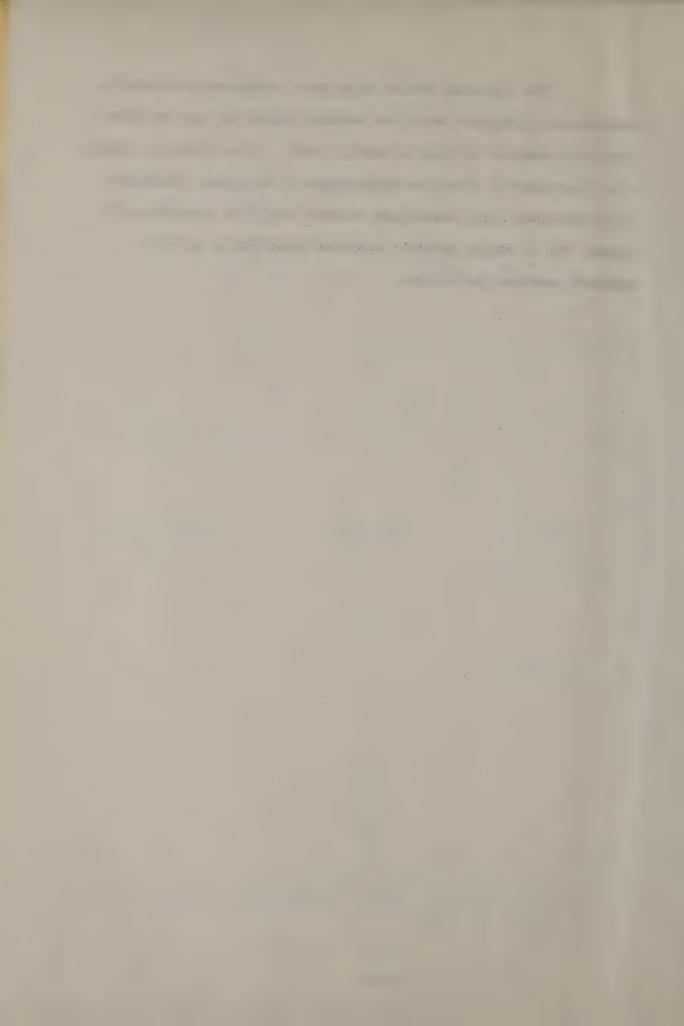
Material	Passing	Dense Grading
Coarse aggregate	3/4"	7.0
	1/2	9.0
	3/8	16.0
Fine aggregate	#4	7.0
	6	6.0
	8	10.0
	16	19.0
	50	9.5
	100	10.0
Cement	200	6.5

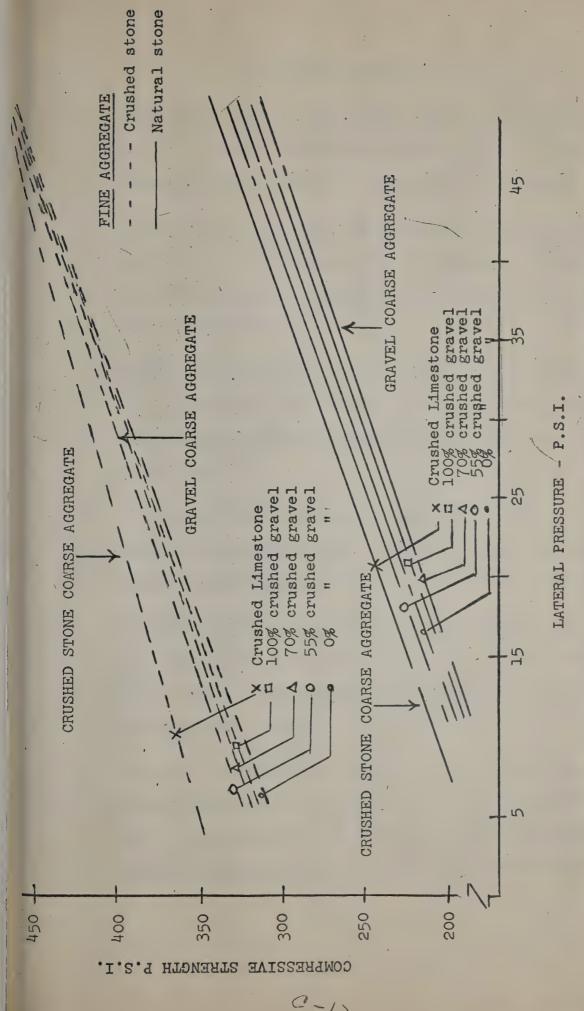
Dy M. Herrin and W. H. Goetz. Proceedings Highway Research Board, 1954. pg. 298



The crushed stone sand gave compressive strength considerably higher than the natural sands as can be seen from the results of the triaxial test. This type of testing is a function of cohesion and angle of internal friction.

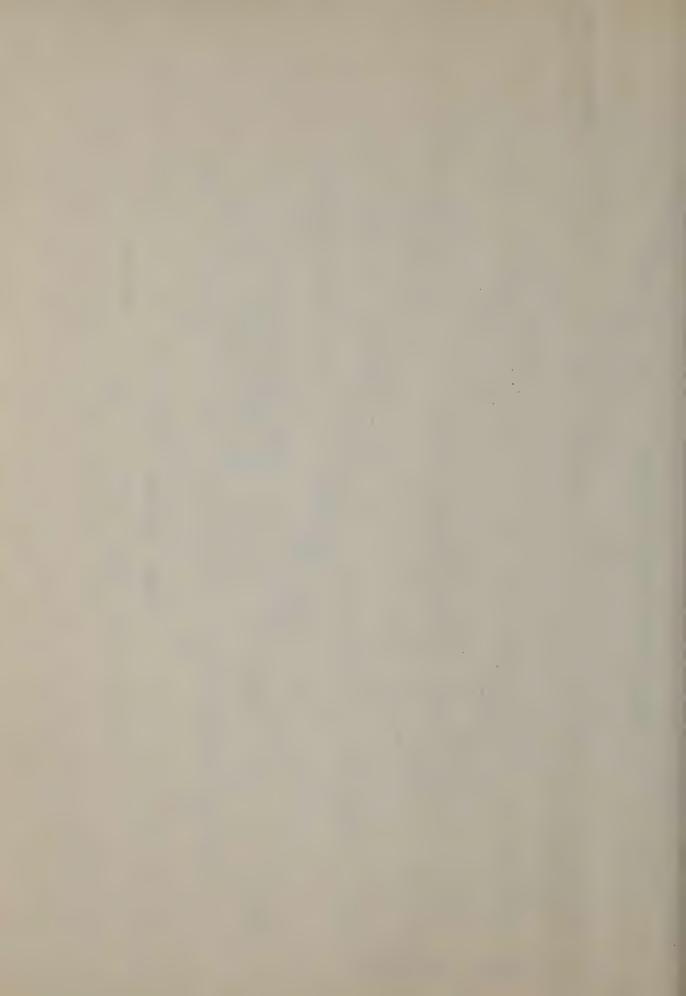
It is obvious that these two values would be considerably higher for a rough surface texture than for a smooth rounded surface particle.





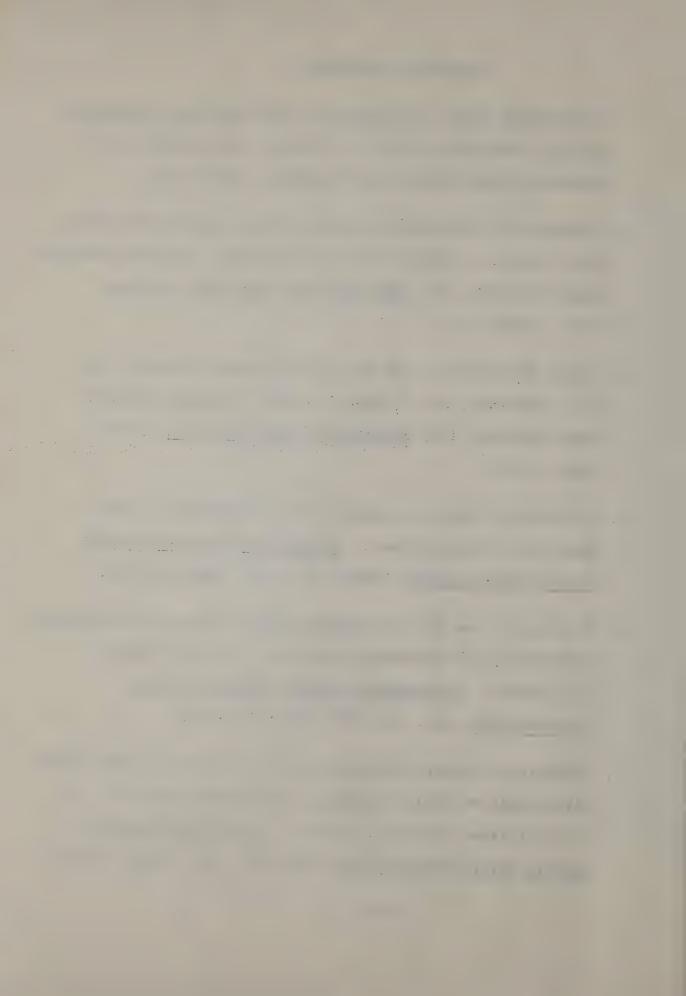
EFFECT OF FINE AGGREGATE TYPE ON COMPRESSIVE STRENGTH

DENSE GRADED MIXTURES



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- 3. "State Practices in the Use of Bituminous Concrete", by W. E. Chastain, Sr., & John E. Burke. Highway Research Board Bulletin 160, Bituminous Paving Mixtures, 1957, Pages 1-107.
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- 7. "The Use of Sand and Gravel in Bituminous Mixtures", by Karl F. Chapel. Proceedings American Asphalt Paving Technologists, Vol. 25, 1956; pages 392-401.
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- 9. "Paving the Maine Turnpike", b Charles F. Parker.

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- 10. "Recent Investigations of Design of Asphalt Paving
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- 11. "The Effects of Using Crushed Gravel as the Coarse and Fine Aggregate in Dense Graded Bituminous Mixtures", by Presley

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- 12. "Stone Quarries Location and Geologic Characteristics"

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- 13. "Fine Aggregate Sources Location and Geologic

 Characteristics" Engineering Research Series, Research

 Report RR 61-2, State of New York, Department of Public

 Works.

A TABLE OF APPROVED SOURCES OF FINE AGGREGATES

Public Works Specifications

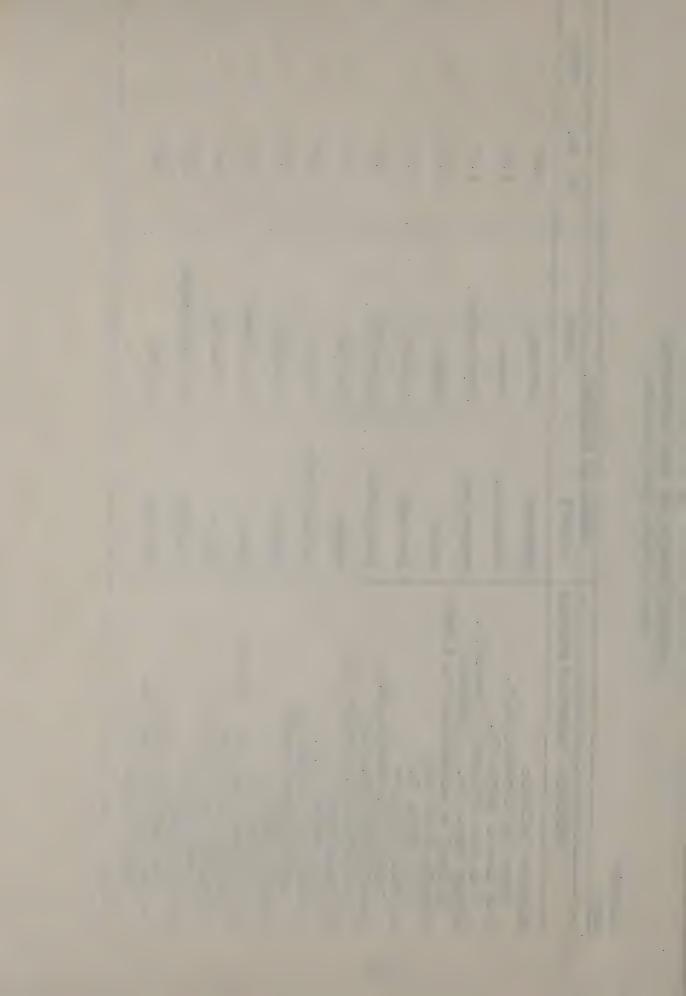
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APPROVED SOURCES OF FINE ACCRECATES Public Works Specifications

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Troy Sand & Grevel Co.	Rensselaer	Nassau	S CV	,0
Albany Gravel Co. (J. Hopkins)	Hensselaer	Stephentown	2.	Q
N. Pearl & Loudenville Rd. Albany Republic Seel Co.	E see	Mortan	0	ರ
Port Henry, N.T. Nicholas Paliette	Saratoga	Corluth	CVI (VI	6
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Marren Aggregates	ration	Chester	N.	ಪ
Chestertown, M.Y. General Sand & Stone Co.	Massachusetts	Dalton	0	O
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Vm. E. Dalley	Vermont	So. Shaftsbury	O.	0
Nudson Valley S. & St. Co. Mechanicville, N.Y.	Seratoga	Noreau	2,70	ಡ
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APPROVED SOURCES OF FINE ACCREGATES Public Works Specifications

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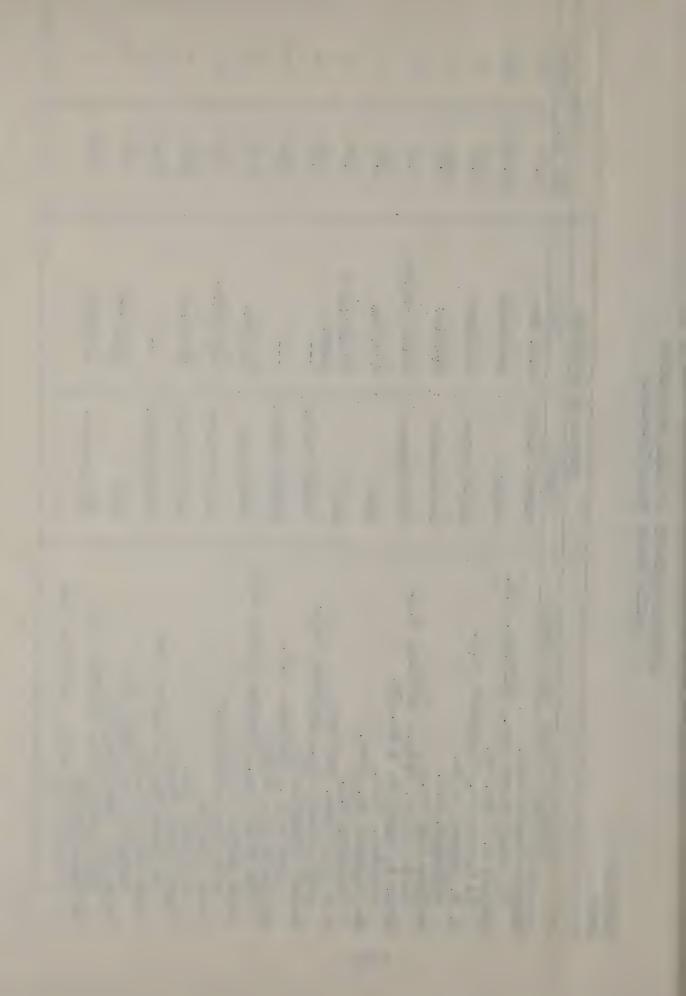
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J. J. Harrington (Bowen Farm)	Cayuka	Sennett	2,5	(°)
I. Davies	Овмево	Scribs	9	
Runsey - Ithaca Corp.	TOWN	Tchaca	S. S	C)
Bero Construction Co.	Cortland		6,63	0
General Crushed Stone Co.	OSMego	Sandy Creek	300	
-	Onondaga	Clas	o, o,	
W. F. Saunders (A. Serson)	Onondaga	Marcellus	2,63	0
Massaro Sand & Gr. Co.	Osmeo	Volney	2,66	Ω
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Misner Farm (Cortland Ready Mix) Box 428, Cortland, N.Y.	%ertland		5,66	O



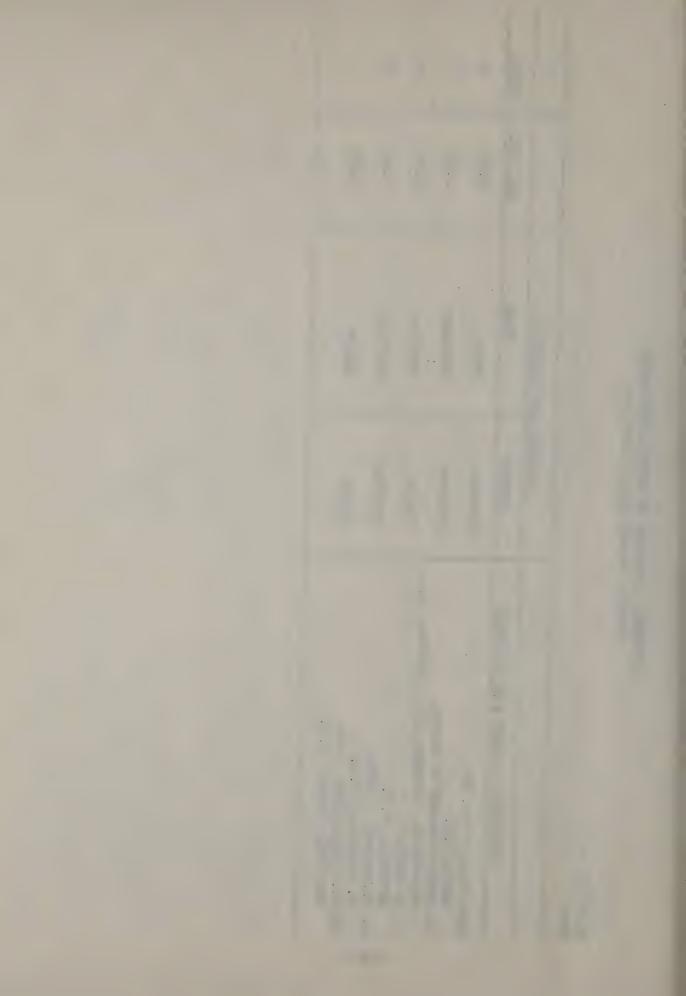
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Frey Sand & Gr. Co.	Genessee	Alexander		0
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Casport S. & Gr. Co.	Niagare	Lockport	0	0
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Allegany, N.Y.	Cattarengus	Macillas	20.02	()
Upper Allegany S. & Gr. Co.	Cattarangus	South Valley	2.67	,Ω
Dan Gernatt Gr. Prod.	E L		20.00	ల
Pine Hill Conc. Mix Corp.		Newstead &	0	Q
Gravel Products Div.	Pennsylvania		29.0	O
falo, M.K.	Pennsylvania	The new Atte	01 01	ej
820 Cedar Ave., Niagara Falls, N.Y. Evans Bldms. Supply	Chaviauqua	Hanover	Ci.	Ω
Work & Silvia	Cattaraugus	Red House	<i>C</i> 1000	Ω,
COTE COTE	Cattaraugus	Machias	2.57	0
Bradfo	Pennsylvania	and many care	9.2	۵
afras St., Erie, Pe.	0	Newstead	3	Q
Buffalo Slag Co. Buffalo, N.Y. Buffalo Slag Co. Ellicott Sq. Bldg., Buffalo, N.Y.	Cattaraujus	Allegany		0
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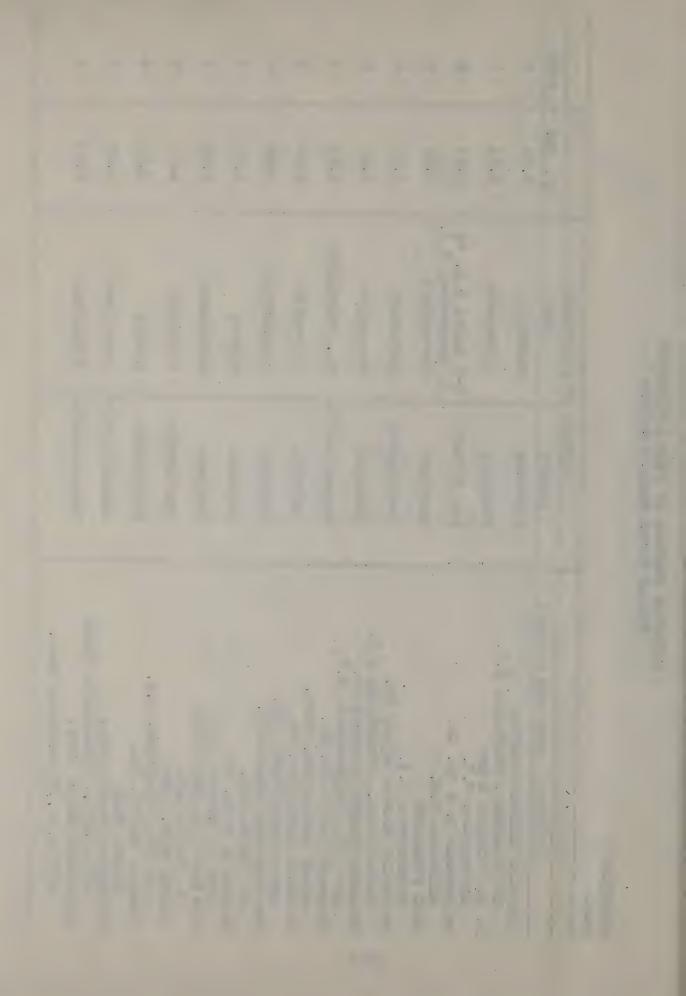
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Bath Sand & Gr. Co.	Steuben	Bath	2,00	0
Dalrymple Gravel & Contg.	Steuben	Corning	600	, (2)
101-105 E. Chemung Fl., Limits, N.Y.	d o	Barton	oi Oi	C)
A. Rhinchart & Sons	Steuben	Corning	2,62	
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Rural Hill Sand & Gr. Co.	Jefferson	Ellaburg	0	C)
Belleville, N.Y. Putnam & Hawley	St. Lawrence	Parlantile	2	C)
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Lyon Mt., N.Y. Bero Constr. Co.	Clinton	Schuyler Palls	3.00	(1)
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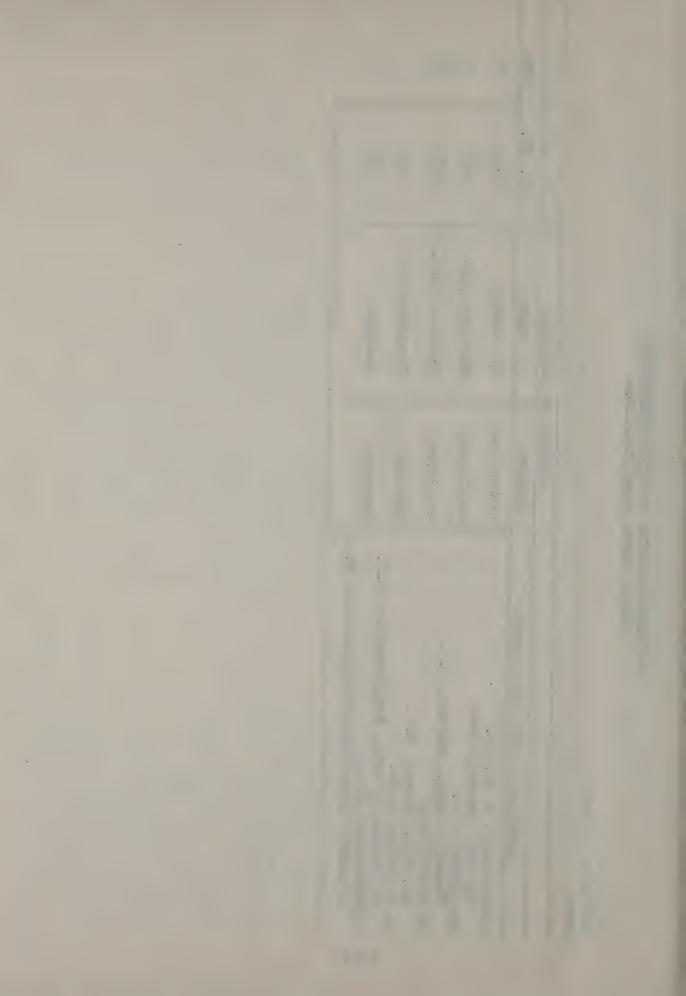


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F. H. Stickles & Son	Columbia	Livingston	63.	Ω,
Dallenbach S. & Gr. Co.	New Jersey	o miles S.E.	30° N	Ø
Ward Pavements	Rockland	M. Drumswick, N.C. Haverstraw	29.0	c3
Peekkill Masons Supply Co.	Test cless to s	Cortlandt	2.70	æ
Dutchess Quarry & Supply Co.	Dutchess	Washington	0,0	٤
Sand & Gr.	Massachusetts	Gr. Barrington	8.63	(2)
Columbia Sand & Gr. Co.	Columbia	Claverack	2	0
New York Trap Rock Corp.	Dutchess	Poughkeepsie	8.00	O
Amenia S. & Gr. Co.	Duteness	Amenia	2,7	0
New York Trap Rock Corp.	Rockland	Haverstraw	2.84	Q
Cooney Bres., Inc.	Westchester	Cortlandt	6.	C
Camereo Control Co.	Yest Chester	Somera	2.63	€ŝ
Berkshire dravel Corp.	Mossaschusette	Lenox Dele	2.70	O
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Stateline S. & Gr. Co.	Connecticut	N. Canaan	60.00	(1)
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F. J. Melito & Co.	Dutchess	Poughkeepsie	6,0	O
Francis Ryan, Inc. Poughkeepsie, M.Y.	Dutchess	Beekman	2,66	
Fiessell niuge noat, foughteepsies N.I.	The state of the s	TEL personal septidal i demonstration or extraction and population — op not included extractive mode, play an experience of the contractive mode, play an experience of the contractive mode, play and the contractive mo	den geller von Verstering in den den den den den den den den den de	

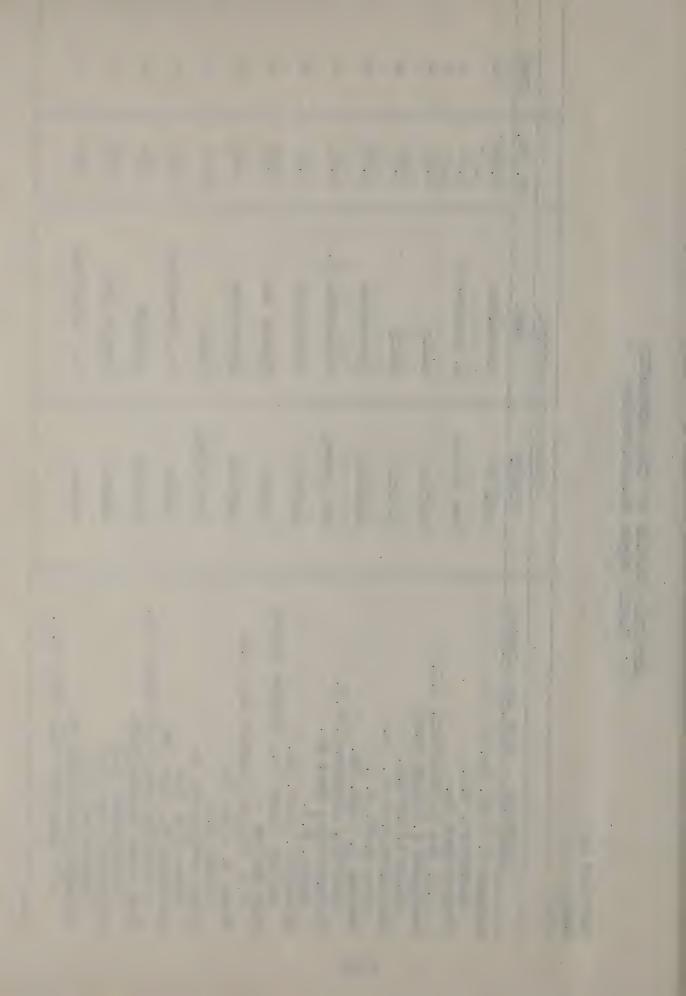


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SUPPLIER - NAME AND ADDRESS	COUNTY		SP. GR.	ICAL
Bundy Conc. Prod. Co. Sherburne, N.Y. Amos Rogers (Contr. S. & G. Co.) R.D. #1, Moscow, Pa.	Chemango	Sherburne	2 2 2	0 0
Barney & Dickenson, Inc. R.D. #1, Vestal, N.Y.	Broome	10713	0 1	ర
Greene N.Y.	Chenango	00000	0	0
Sullivan flwy. Prod. Summitville, N.Y.	Sulivan	Kamakating	d	۵٫



DISTRICT 10 Sand

	SOME	OF MATERIAL	And the state of t	Planteriorant Plante, egginerotation de territorio de sectiones
SUPPLIER - NAME AND ADDRESS		TOWN	SP, CR.	product production is a second contract production of the second contract of the second con
Wivehar S. & Gr. Co.	Suffolk	Brookhaven	0000	ø
	New Jersey	E. Brunswick	9	ø
Preferred S. Shore Plant	Suffolk		C)	đ
Deer Park S. & Gr. Co.	Suffolk		8	æ
Roanoke S. & Gr. Co.	Suffolk	Brookhaven	a a	Ø
Raritan River Sand Co.	New Jersey	Middlesex, N.J.	٣ %	æ
Bastern S. & Gr. Co.	Suffolk	Brookhaven	9	ø
Pine Hollow	Nessau	Oyster Bay	99,0	۵
Coram S. & Gr. Co.	Suffolk	Brookhaven	°, °,	cd
Allen Wood Steel Co.	New Jersey	Dover	8	Ø
	Massaa	No. Hempstead	0	Ø
East Coast Lumber Term.	Suffolk	Babylon	\$	æ
Fehr Sand & Gr. Co.		Oyster Bay	8	đ
Colonial Sand & Gr. Co.	Nesse M	No. Hempstead	3	ಹ
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DISTRICT 10 (cont.)

		SOURCE OF MATERIAL	ealth succession of a design equalifying could people the equation of the country of the and the country of the equation of the country of	
SUPPLIER - NAME AND ADDRESS	SOUNTE		SP. GR.	TYPE
Eastern Suffolk Conc. & Asph.	0	Southampton	o, vi	ø
Colonial (Metro) S. & Gr. Co.		No. Hempstead	3	es.
J. R. Steers	Suc	Huntington	990	Ø
Approved S. & Gr. Co.	N SS SS	Oyster Bay	8	ø
344 Duffy Ave., Oyster Bay Industrial S. & Gr. Co.	Suffolk	Snithtown	e e	æ
Consolidated Sand & Gr. Co.	Suffolk	Huntington	2000	ಥ



